PB81-128639

Residential Water Conservation
An Annotated Bibliography

Pabon, Sims, Smith and Associates
Washington, DC

Prepared for

Department of Housing and Urban Development
Washington, DC

6 Feb 80

U.S. Department of Commerce
National Technical Information Service
NTIS

HUD-0001757

United States
Environmental Protection
Agency

Office of Water
Program Operations (WH-595)
Washington, DC 20460

In cooperation with the
United States Department of
Housing and Urban Development

Water

March 1980

PB81-128639

EPA

Residential Water Conservation:

An Annotated Bibliography

FRD-16

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA 22161

Disclaimer Statement

This report was prepared under contract to the U. S. Department of Housing and Urban Development. The findings and conclusions are those of the contractor, and do not necessarily reflect the policy or views of the U.S. Department of Housing and Urban Development.

This bibliography has been reviewed by the Environmental Protection Agency and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

NOTES

To order this publication, FRD-16, "Water Conservation: An Annotated Bibliography" write to:

General Services Administration (8BRC)
Centralized Mailing List Services
Building 41, Denver Federal Center
Denver, Colorado 80225

Please indicate the FRD number and title of publication.

50272-101

REPORT DOCUMENTATION PAGE

1. REPORT NO. HUD-0001757
EPA/FRD-16

2.

3. Recipient's Accession No. PB81 128639

4. Title and Subtitle
Residential Water Conservation: An Annotated Bibliography.

5. Report Date
80/02/06

6.

7. Author(s)

8. Performing Organization Rept. No.

9. Performing Organization Name and Address
Pabon, Sims, Smith and Associates, Inc.
Washington, DC 20005

10. Project/Task/Work Unit No.

11. Contract(C) or Grant(G) No.
(C) Contract HUD-H-5091
(G)

12. Sponsoring Organization Name and Address
Environmental Protection Agency, Washington, DC.
Office of Water Program Operations.
Department of Housing and Urban Development, Washington, DC.
Office of Policy Development and Research.

13. Type of Report & Period Covered

14.

15. Supplementary Notes

Sponsored in part by Department of Housing and Urban Development, Washington, DC. Office of Policy Development and Research.

16. Abstract (Limit: 200 words)

This annotated bibliography of 155 references lists publications on water conservation tips, water conservation devices, water conservation projects, and economics regarding residential water conservation and regional variables. Useful information is summarized from the references and is included in the booklet in tables and a narrative following the listings. It pertains to water conservation projects cost/savings, energy/water savings, and residential water use. Information sources are the National Bureau of Standards; personal contacts with trade associations; local, State, and Federal officials; water utilities; universities; environmental organizations; literature review of libraries in Washington, D.C.; and manufacturers' and distributors' information on products and prices. Listed alphabetically by author, each citation has the author, title, publisher (when available), publication date, publisher's city and State, and number of pages. A subject index is also provided. No availability or pricing information is given.

→ over

17. Document Analysis a. Descriptors

b. Identifiers/Open-Ended Terms

APPROVED
P D & R REPORTS CONTROL
RAE 12-8-80

c. COSATI Field/Group

I

18. Availability Statement
Available NTIS

19. Security Class (This Report)

20. Security Class (This Page)

21. No. of Pages 122

22. Price A06 - A01

(See ANSI-Z39.18)

See Instructions on Reverse

OPTIONAL FORM 272 (4-77)
(Formerly NTIS-35)
Department of Commerce

EPA
FRD-16

RESIDENTIAL WATER CONSERVATION:
AN ANNOTATED BIBLIOGRAPHY

Prepared for the
U. S. Department of Housing
and Urban Development

Office of Policy Development
and Research

Washington, D. C.

Published by the
U. S. Environmental Protection
Agency

Office of Water Program
Operations

Washington, D. C.

Prepared under HUD Contract Number H-5091 by
Pabon, Sims, Smith and Associates, Inc.
1435 G Street N.W. Suite #603
Washington, D.C. 20005

February 6, 1980

Preceding page blank

from BDS

CONTENTS

Some of the areas covered, include:

EPA Comment i

Part One - Annotated Bibliography . . . . 1 - 44

Part Two - Summary of Data in Bibliography

Conservation Projects 45

Cost Savings. 51

Energy Requirements 56

Energy/Water Savings 62

Sewerless Wastewater Disposal Devices 79

Regional Issues 83

Residential Water Use 85

Water Rates 97

and Water Saving Tips 98

Subject Index by Bibliography Reference Number 109

EPA COMMENT

On June 6, 1978 President Carter sent a Message to Congress initiating a federal policy to "provide a new, national emphasis on water conservation."

He said in part,

> "Managing our vital water resources depends on a balance of supply, demand and wise use. Using water more efficiently is often cheaper and less damaging to the environment than developing additional supplies. While increases in supply will still be necessary, these reforms place emphasis on water conservation and make clear that this is now a national priority."

The U.S. Environmental Protection Agency and the Department of Housing and Urban Development have, as a result of this directive, undertaken major efforts to produce and disseminate information about residential water conservation. EPA and HUD will both publish books on this subject in order to explain why, how, when and where individuals and communities can conserve water and reduce wastewater flows; conserve energy; and save money. EPA's booklet will be short, direct, and will emphasize cash savings to individual households by the sound environmental practice of water conservation. The HUD book will be larger. It will give detailed advice for implementing many residential water conservation measures.

This bibliography is the result of a literature search done for the latter publication. I would like to thank HUD for permitting EPA to publish this useful bibliography. Their cooperation and the efforts of Joan Simons, HUD Government Technical Representative, and Barbara Yeaman, Public Education Consultant on my staff have made it possible to share this information with others working to implement the National water conservation policy.

A search of five carefully selected subjects has produced a comprehensive listing of publications on:

- Water conservation tips
- Water conservation devices
- Water conservation projects
- Economics
- Regional variables

Other useful information is summarized from the references and included on:

- Community water conservation projects
- Cost/savings
- Energy/water savings
- Residential water use

Sources of this information include:

- National Bureau of Standards
- Personal contacts with trade associations; local, state and federal government officials; water utilities; universities; environmental organizations; and other knowledgeable individuals
- Literature review of libraries in Washington, D.C.
- Manufacturers' and distributors' information on products and prices

Communities planning water conservation programs may find this bibliography especially useful.

Unfortunately, a bibliography can never be complete or fully current. EPA and HUD regret the omission of any publications, manufacturers, distributors, or programs.

Mention of trade names or commercial products does not constitute endorsement or recommendation for use by EPA or HUD. Approval of the bibliography does not signify that the contents of all publications listed necessarily reflect the views and policies of EPA or HUD.

William A. Whittington
Director, Facility Requirements Division
Office of Water Program Operations
US EPA

PART ONE

ANNOTATED BIBLIOGRAPHY

Abbott, H., K. G. Cook, and R. B. Sleight. Social Aspects of Urban Water Conservation. August 1972.

1* - A survey of managers and customers of 17 eastern U.S. water utilities that imposed short-term water use restructions was conducted. The survey of customers revealed that most agreed that outside uses are least essential. During a water shortage, cooperation was excellent and continued even after the emergency ended. Water-saving measures achieved from 18% - 50% reduction in water use with voluntary measures being as effective as compulsory ones. Although most consumer respondents do not want restrictions in normal times, half of the respondents were not willing to pay 10% more for their water to insure adequate supplies.

Alley, D. Baumann, J. Boland, P. Carver, B. Kranzer, and J. Sims. An Annotated Bibliography on Water Conservation. Institute of Water Resources, U.S. Army Corps of Engineers, April 1979.

2 - The work documented in this report was conceived and planned in response to the need by the U.S. Army Engineer Institute for Water Resources (IWR) in the Spring of 1978. This effort represents a survey of the currently available literature on water conservation measures. The studies reported in this volume were selected as being representative of the major problems involved in evaluating water conservation: The technical effectiveness of available conservation measures, the evaluation of economic efficiency, and the question of social acceptability. For each source in this volume an effort was made to describe the objective(s), to report the methodology, and to summarize and critically appraise the salient findings.

American Water Works Association. Water Conservation At Home. Denver, Colorado, 1975. 12 pp.

3 - This consumer booklet gives household water conservation tips suitable for children as well as adults. It includes brief sections on toilets and toilet maintenance, showers, kitchens, laundry, how to detect and fix leaks, water-saving devices, shut-off valves and emergencies, and outdoor water-saving.

Baily, Benoit, Dodson, Robb and Wallman. A Study of Flow Reduction and Treatment of Waste Water from Households: Project Report for Federal Water Quality Administration. Department of Interior, Advanced Waste Treatment Research Lab, Cincinnati, Ohio. December 1969, U.S. Government Printing Office.

4 - This study was conducted to find practical means of waste flow reduction or waste treatment for the ordinary household. First, the present water quality and quantity requirements were reviewed to determine the areas where better water and waste management would be most beneficial.

---

* Bibliography Reference Number

Much helpful material was gathered from review of previous studies on the problems of individual household waste treatment. More recent information was obtained from manufacturers of plumbing devices and waste treatment equipment who were surveyed for available water-saving plumbing devices and individual waste treatment units. Also, the literature on advanced water and waste treatment was reviewed for processes that might be applicable for individual home usage.

The information collected was then analyzed to determine the most practical method for decreasing the waste volume flow from individual households. Homeowners, plumbers, architect-engineers, and equipment manufacturers were surveyed to obtain representative opinions from the people who would control the use of any flow reduction or treatment schemes. The results of the study and the consumer survey show that the water used in household functions such as bathing and toilet flushing can be substantially reduced by the use of more efficient appliances and plumbing devices. The use of most advanced waste treatment techniques and the reuse of waste waters is not considered practical except for cases of unusual problems and extremely high water or waste disposal costs.

Baker, L. K. The Relationship Between Water and Energy Use and Conservation; Proceedings; 1976 Summer Workshop on an Energy Extension Service, held at Lawrence Berkeley Laboratories, Unviersity of California, Berkeley. Energy Resources Development Authority, May 1977. p. 329-334.

5 - The energy savings that result from water conservation may prove to be of more significance than the water saved. Water heating consumes far more energy than water supply or sewage treatment. However, when a high degree of treatment is required, or large pumping demands exist, significant savings in energy are obtained through water conservation.

Reductions in household water use of 68% and water heating energy consumption of 62% can be achieved by using new fixtures available today. In order to achieve these significant reductions in flow rate, the fixtures must be completely redesigned, and quite often require different technology. The toilet, shower, and laundry use 84% of the inhouse water. The toilet and shower can be reduced by approximately 90%, while the washing machine can be reduced by 40%. The reduction of the bathing and laundry water reduces water heating requirements.

Baker, L., and H. Bailey. Household Water Conservation Effects on Water Energy and Wastewater Management; Proceedings; Conference on Water Conservation and Sewage Flow Reduction with Water-Saving Devices. Pennsylvania State University, University Park, Pennsylvania, April 1975. p. 71-87.

6 - Water conserving equipment for the household can have a significant impact on water use, energy consumption, and wastewater treatment. The process of water supply from acquisition through use, treatment, reuse, and disposal is analyzed with emphasis on the role of the house-

hold. Each water consuming element or function in the household is analyzed on the parameters of water use, waste contribution, and energy consumption.

Technology is immediately available for reducing household flows and new technology can reduce flows by approximately 65 percent. Associated energy reductions within the household are approximately 30 percent of the non-space heating and cooling requirements. Zero discharge or recycling of a water stream requires treatment systems which depend on chemical, physical, and/or biological processes, with an associated energy driving force. Minimized water use implies more concentrated waste. Treatment facilities can be designed more effectively in lower hydraulic flow regimes. Implications for selected advanced treatment unit processes are discussed.

Energy savings associated with reduced flow equipment have significant economic ramifications. Dollar savings not only can offset first costs, but contribute to the cost of treatment. An annual cost economic analysis is performed on conventional systems with conventional treatment versus reduced flow systems with advanced treatment. It is concluded that the savings associated with reducing flows contribute significantly to offsetting the increased costs of energy consumption and resource depletion of advanced treatment systems necessary to achieve zero discharge.

Bauman, D., J. Boland, J. Sims, B. Kranzer, and P. Carver. The Role of Conservation in Water Supply Planning. Institute for Water Resources, U.S. Army Corps of Engineers, Fort Belvoir, Virginia, April 1979.

7 - This is a report prepared by the Southern Illinois University, Department of Geography for the Army Corps of Engineers. The report has three major sections: First, it establishes a definition of water conservation; secondly, it reviews the state-of-the-art information on conservation measures; and finally, it identifies requirements and needs for implementation. In its review of conservation methods, residential, industrial and agricultural uses are examined. Data are presented on the costs and potential savings associated with various methods and mechanisms.

Bauman, D., D. Dworkin, S. Sebastian, B. Andrews, and D. Holtz. Planning Alternatives for Municipal Water Systems. Holcomb Research Institute, Butler University, Indianapolis, Indiana, 1976. 67p.

8 - This report examines the supply and demand picture of water supply. Once methods of reliably predicting demand have been developed, and future supply has been defined, a number of planning alternatives are presented. Planning methodologies examined include improving system efficiency, reducing water demand, and reusing water. Technological innovations in water supply are also examined.

Bennett, Edwin R. Impact of Flow Reduction on On-lot Sewage Systems; Proceedings; Conference on Water Conservation and Sewage Flow Reduction with Water Saving Devices, Pennsylvania State University. U.S. Department of Commerce, NTIS PB 250 999, July 1975. p. 39-56

9 - Water saving appliances will have an important role in water and sewage system planning in the arid southwestern and mountain states of the U.S. The most timely applications of this concept may involve individual, isolated homes in unsewered areas, because of the costs and operational problems associated with on-lot sewage disposal. Nearly one-third of the homes in the United States are located in unsewered areas.

A recent study at the University of Colorado has been directed towards studying individual home water use and on-lot sewage treatment systems. From this work, the normal water use patterns are presented and used as a basis for estimating the benefits of flow reducing appliances on operational parameters and costs of on-lot systems.

Bishop, Walter. Field Experiences in Water Saving Programs of the WSSC; Proceedings; Conference on Water Conservation and Sewage Flow Reduction with Water Saving Devices, Pennsylvania State University. U.S. Department of Commerce, NTIS PB 250 999, July 1975. p. 39-56

10 - Various practices for saving water at the customer level are in most cases mechanically and theoretically quite simple. The documented evidence of laboratory studies and carefully controlled field testing shows the relative ease with which reduction in water consumption can be realized by using various appliances and retrofitted devices. However, in studies conducted by the Washington Suburban Sanitary Commission over a period of four years, the results have shown that water savings are not guaranteed. The distinction between theory and field conditions and cases of success and failure in water savings programs were discussed. The practical experiences of WSSC concerning each type of case were presented.

Bollman, Frank, and M. Merritt. Community Response and Change in Residential Water Use to Conservation and Rationing Measures, October 1977.

11 - A survey of 1,000 households in the Marin Municipal Water District, California, showed that the 1976 ban on outside water use achieved a 25% reduction in total water use. A "moderately inconvenient" rationing plan achieved a reduction of 63%. Most respondents felt they could conveniently live with a level of 100gal./person/day or less, as compared to an average pre-drought level of 125 gal./person/day.

Brigham, Arthur. "A Public Education Campaign to Conserve Water." American Water Works Association Journal, 665-668, Dec. 1976.

12 - A water-saving program started in 1971 by the Washington Suburban Sanitary Commission (WSSC), including extensive publicity and the mailing of water saving kits, resulted in a substantial reduction in water use. Their first effort, the development of the WSSC's water saving and waste reduction handbook, "It's Up to You," had tremendous response, and was distributed to the Commission's 220,000 customers. Another project, started in 1973, was the "Bottle Leak Detection Kit" which was also aimed at all the residents of the area. Questionnaires were distributed to check the effectiveness of the kits. Almost 70% indicated they tried the dye test for toilet leaks, and 16% said they found leaks which were adjusted or repaired. Following the bottle kit project, water consumption was reduced almost 4.5% from the minimum projected average daily consumption that might have been expected to occur without the water-saving and waste-reduction program. Recent WSSC activities include water conservation contests and the production of a water conservation film which can be shown to groups and schools.

Brigham, A. P. Public Education Campaign to Cut Water Use; Proceedings; American Water Works Association Conference, June 1975.

13 - The five-year project of the Washington Suburban Sanitary Commission aimed at educating the public about water conservation resulted in a 6-17% reduction in water use from 1973 through 1974. Projects included a water-saving handbook, workshops, speaker programs, and a media blitz.

Bruvold, W. H. Consumer Response to Urban Drought in Central California. National Science Foundation Grant Final Report, June 1978. p.58-66.

14 - This paper evaluates San Francisco's response to drought and concludes that the mild conservation programs were able to attain a 20% reduction in water use.

The study concludes that rationing should be mandatory, rather than voluntary, and that rationing plans should be based upon the number of people per household, rather than the previous average use, size of lot, or ability to pay.

California Department of Water Resources. Are You Using Gray Water During the Drought? California Department of Water Resources, Sacramento, California. 4 p.

15 - Gray water is all wastewater which comes from a home except for toilet water waste (black water). This article explains when gray water can be reused and possible health hazards. It is recommended that gray water be used for flushing toilets. Gray water can also be used for outdoor watering needs. For landscape use, the order of preference for gray water sources is: bath water, bathroom sink, washing machine or clothes washing, dish washing, and kitchen sink water.

The article also explains how to collect and transport gray water from its source in order to use it, and the best way to apply gray water to the landscape.

California Department of Water Resources. Automatic Clothes Washers. California Department of Water Resources, Sacramento, California, February 1977.

16 - This bulletin lists the makes, model numbers, capacities and water-using features of many automatic clothes washers available on the market. An estimated average water use for washers is 40 gallons per cycle.

California Department of Water Resources. Automatic Dishwashers. California Department of Water Resources, Sacramento, California, February 1977.

17 - Average automatic dishwashers use 13-16 gallons for a 60-minute cycle, while some new water-saving models use only 7.5 per load. This bulletin lists the makes, model numbers, and capacities of automatic dishwashers available on the market.

California Department of Water Resources. Faucet Flow Controls. California Department of Water Resources, Sacramento, California, February 1977.

18 - Using flow controls, faucet flow rates as high as 8-12 gallons per minute can be reduced to as little as 2 gallons per minute. This could save about 4.5% of household water use. This bulletin lists faucet flow controls available on the market and discusses their water-saving capabilities.

California Department of Water Resources. Hints for Home Landscaping. California Department of Water Resources, Sacramento, California, May 1977.

19 - This bulletin discusses when and how to water lawns and gardens and how much water is necessary. It also suggests ways to cut frequency of watering. Included in the bulletin is a list of information sources in the Bay Area, the South Coast, the Central Valley Area, and the Central Coast Area of California where more detailed information on drought-resistant plantings and demonstration gardens is available.

California Department of Water Conservation. Hints for Water Conservation. California Department of Water Resources, Sacramento, California, February 1977.

20 - This bulletin lists many general ways for the homeowner, the small farmer, and small businesses to conserve water. The list includes tips, such as taking shorter showers, and devices which may be helpful, such as installing a pressure reducer if the pressure on one's line is greater than 50 pounds per square inch.

California Department of Water Resources. Low Flush Toilets. California Department of Water Resources. Sacramento. California, February 1977.

21 - Conventional toilets use 5-7 gallons per flush, but low-flush toilets only use about 3.5 gallons per flush. This bulletin lists the low-flush toilets available on the market.

California Department of Water Resources. Low-volume Shower Heads and Adapters. California Department of Water Resources, Sacramento, California, February 1977.

22 - Conventional showers use up to 10 gallons a minute. Flow control inserts can cut this rate to 3 gallons per minute, resulting in a 70% reduction of water use in showers. This bulletin lists low-flow showerheads and adapters available on the market and discusses their water-saving capabilities.

California Department of Water Resources. A Pilot Water Conservation Program. Bulletin 191. California Department of Water Resources, Sacramento, California, October 1978. 64 p.

23 - This bulletin reports on a study of the best and most cost effective ways to introduce water conservation devices into homes. It is based on pilot projects conducted during the summer and fall of 1977 in six California communities of diverse characteristics and settings.

California Department of Water Resources. A Pilot Water Conservation Program; Appendix G: Device Testing. California Department of Water Resources, Sacramento, California, March 1978. 399 p.

California Department of Water Resources. A Pilot Water Conservation Program; Appendix H: Device Selection. California Department of Water Resources, Sacramento, California, March 1978. 114 p.

24 - The purpose of the pilot water conservation program was to determine the feasibility of implementing water conservation in California households through the distribution of water saving toilet and shower devices. Appendix G contains the bidding and testing procedures used in selection of water saving devices for use in the Pilot Water Conservation Program. It also presents the performance data developed during the testing of the shower and toilet devices.

An American National Standards Institute test procedure was used to test all toilet devices submitted. The shower device testing procedure developed was discussed with the National Bureau of Standards Plumbing Laboratory staff as well as the staff of a California Independent Testing Laboratory. The intent of Appendix H is to provide the consumer and public or private agencies with an independent analysis of water saving devices evaluated under the same test methods.

The Department may not be cited as a testing agency or as approving any device for any function without prior written approval.

California Department of Water Resources. A Pilot Water Conservation Project: Letter Report. California Department of Water Resources, Sacramento, California, December 1977. 6 p.

25 - The purpose of the pilot study was to gather information on the feasibility of implementing water conservation in California households through the use of water saving shower and toilet devices. To determine such feasibility the Department evaluated 1) the effectiveness of various methods of distributing of water saving devices to households; 2) the willingness of citizens to use various types of shower and toilet devices; and 3) the effectiveness of the various devices in reducing water and energy consumption.

Six communities with varying water conditions were chosen for the study: San Diego, Santa Cruz County, the City of Sanger, the City of El Segundo, the El Dorado Irrigation District, and the community of Oak Park (near Ventura). Distribution of devices and follow-up telephone or mail surveys were completed in all six communities, and analysis is in various stages of completion in each area.

California Department of Water Resources. Proceedings; An Urban Water Conservation Conference. California Department of Water Resources. Sacramento, California, January 1976.

26 - This report is a collection of presentation transcripts covering the water conservation spectrum: Why, What, How, and Who. While most articles are of a general nature, some summary data is presented on water supply, use, associated energy use, specific conservation mechanisms and programs, and some discussion of rate alteration effects.

California Department of Water Resources. Save Every Last Drop! California Department of Water Resources, Sacramento. California. 4 p.

27 - This folder includes many tips on various ways to save water including how to fix a leaky faucet, how to use less water in the toilet, water saving appliances, other devices and techniques to save water in the home, how to read one's water meter, and home landscaping tips.

California Department of Water Resources. Save Water. California Department of Water Resources, Sacramento, California. 8 p.

28 - This report provides a general discussion for consumers of indoor and outdoor possibilities for saving water. Household tips discussed include water-conserving toilets, showers, clothes washers and dishwashers as well as hot water pipe insulation. Outdoor tips include garden watering methods, and best ways to design and maintain a garden. Also included are ways that water utilities

can reduce water waste and agricultural water savings. The report concludes that a 10% reduction in water use through reasonable conservation practices could save as much as 615 cubic hectometers of water a year in California. Energy savings from reduced water use could also be substantial.

California Department of Water Resources. The 1976-77 California Drought: A Review. California Department of Water Resources, Sacramento, California, May 1978. 228 p.

29 - This report places the entire 2-year California drought in perspective. It documents the impact of the drought and details the response by Federal, State, and local governments and the public. At the height of the drought, one-third of all Californians were participating in mandatory programs and nearly all the rest were involved in voluntary programs. California urbanites conserved, on the average, over 20% of normal water use--a remarkable achievement. It also discusses lessons learned from the drought and suggests future actions to better use water and includes an extensive bibliography.

California Department of Water Resources. Toilet Damming Devices. California Department of Water Resources, Sacramento, California, February 1977.

30 - Toilet dams save water by blocking off part of the toilet tank and thereby requiring less water to fill the tank. Savings can range as high as 2 gallons per flush, and devices can save 5-10% of the fresh water used within a home. This bulletin lists toilet damming devices available on the market, and discusses their water-saving capabilities.

California Department of Water Resources. Water and Energy Conservation for the Boy Scouts of America. California Department of Water Resources, Sacramento, California.

31 - This brochure is designed to help Boy Scouts qualify for a water conservation badge. It teaches Boy Scouts the relationship between water, energy, and the environment, and how everyday activities affect water conservation.

California Department of Water Resources. Water Conservation. California Department of Water Resources, Sacramento, California. 2 p.

32 - This very general brochure focuses on the potential savings in residential water use. In California, 75% of the indoor residential water used is in the bathroom. Substantial water can be saved in existing homes by modifying in-place fixtures (retrofitting). The brochure includes charts of potential energy and water savings possible from shower and toilet modifications.

California Department of Water Resources. Water Conservation in California. Bulletin 198. California Department of Water Resources, Sacramento, California, May 1976. 95 p.

33 - This is a detailed report on water use in California. The report examines residential, industrial, and agricultural water use patterns and a large number of mechanisms and strategies for consumption reduction in each area. The report presents potential savings of both water and energy associated with each of the mechanisms presented. In its analysis, the report reviews and compiles statistics on most toilet and shower devices available as well as indoor and outdoor use reduction.

California Department of Water Resources. Water Pricing. California Department of Water Resources, Sacramento, California, February 1977.

34 - The importance of water costs as they relate to conservation are discussed. Included is a table of the various pricing systems used in California, their effect on conservation, and their relative equity. The Department recommends that local water agencies use uniform peak/seasonal, or increasing block rates. The lifetime rate should be included in the system so all basic needs are met equitably. All means to increase efficiency of water use should be examined and put into effect where they are reasonable and prudent.

California Department of Water Resources, Office of Appropriate Technology. Drought Garden Plant List. California Department of Water Resources, Sacramento, California.

35 - This bulletin lists trees, shrubs and groundcover vegetation that are drought-resistant and appropriate for Sacramento, California's climate.

California Water Resources Center. What We Can Do Before The Well Runs Dry! University of California, Davis, California. April 1977. 16 p.

36 - This report summarizes some of the salient portions of Milne's Residential Water Conservation. The sections covered include: What can be done now, without cost; what can be done soon, with some expenditures; and what yet needs to be done, requiring some changes in laws and building codes. It includes indoor and outdoor water-saving tips and systems that can be implemented to save water in the future.

Cassel, G. and J. O'Reilly. "PMI Seminar Promotes Water Conservation." Supply House Times, 76-87, Nov. 1978.

37 - This article summarizes a 1978 conference of the Plumbing Manufacturers Institute emphasizing the need for nationwide flow rate standards. Enforcement of water conservation standards is critical. However, since a water conservation showerhead looks exactly the same as its conventional counterpart, it is almost impossible for plumbing inspectors to make sure that water conservation products are being used. Some sort of uniform labeling on the product itself is therefore essential.

Chan, M. C. and Steve Heare. The Cost-Effectiveness of Pricing Schemes and Water Saving Devices; Proceedings; Conference on Water Conservation and Sewage Flow Reduction with Water Saving Devices, Pennsylvania State University. U.S. Department of Commerce, NTIS PB 250 999. p. 23-38.

38 - The cost savings of various water-saving options to reduce household wastewater flow and water consumption were enumerated in this study. These options included the installation of water-saving devices and the adoption of pricing schemes. Two computer models were constructed. Water-saving devices were evaluated with respect to cost savings to households, water utilities, and wastewater industries. Pricing schemes were evaluated for various climatic regions and housing types with respect to consumer surplus, producer surplus, the sum of consumer surplus and producer surplus, distributional effects across income classes, revenue adequacy, ability to conserve water, and savings to water and wastewater industries. Public acceptance and the legal constraints of these water-saving devices and pricing schemes were also investigated. An extensive literature review on the state-of-the-art of this problem was also conducted.

Cole, C. A. Impact of Home Water Saving Devices on Collection Systems and Waste Treatment; Proceedings; Conference on Water Conservation and Sewage Flow Reduction with Water-Saving Devices, University of Pennsylvania, Pennsylvania State University, April 1975. p. 47-55.

39 - Water conservation using domestic water saving toilets will have an impact on sewage collection and treatment if infiltration is controlled. Sewer solids handling efficiency was evaluated for toilets discharging 5.25 gallons per flush (U.S. average) and less. It was concluded from calculations using Manning's formula that solids transporting capacity of sewers and house connections would not be substantially changed until the flush amount was reduced to 2.0 gallons per flush or less. Even lower gallons per flush would not affect the solids handling capacity for sewers with over 500 population contribution. The treatment plant hydraulic design capacity would be substantially extended if all future toilet installations were to be made with 3.5 gallon per flush devices. These theoretical calculations should be verified by field demonstrations and evaluations.

"Saving Water in the Home: 1. When You Flush the Toilet; 2. When You Take a Shower." Consumer Reports, 43(5): 297-302, May 1978.

40 - Consumer Reports conducts thorough tests on 28 toilet water-saving devices and ranks them according to costs and benefits. Also included is a list of do-it-yourself means of reducing toilet water use. Results indicate that none of the devices work any better than the do-it-yourself methods.

Tests were also conducted on 28 low-flow showerheads and 19 flow restrictors. Costs/benefits are discussed and devices are ranked.

"Washing Machines." Consumer Reports, 572-577, Oct. 1978.

41 - Consumer Reports examines washing machines and ranks them according to a number of criteria, including their economical use of water and electricity.

"Water: Time To Start Saving?" Consumer Reports, 294-296, May 1978.

42 - This article explains the importance of conservation and how to live with less water. Consumer Reports tested 28 water-saving devices for toilets, including dams, weights, dual-flush units, air bleeds, replacement tanks, and flush valve stops. However, they concluded that a bottle in the toilet tank or a homemade weight (described in article) would be just as effective as all the products tested, and therefore didn't recommend any of them.

Consumer Reports also tested shower devices, such as flow restrictors, regular low-flow showerheads, and aerating low-flow showerheads. They concluded that a flow restrictor will conserve water, and priced at $2 or less each, will cost less to buy than a completely new showerhead. Low-flow showerheads, however, do not decrease enjoyment of the shower as much as flow restrictors. Aerators, although unadjustable, save more water than the regular low-flow showerheads.

Copley International Corporation. An Evaluation of Alternative Methods of Distributing Water Saving Kits. California Department of Water Resources, La Jolla. California, Dec. 1977. 203 p.

43 - The research project described in this report was conducted to evaluate the effectiveness of the California Department of Water Resources San Diego Pilot Water Conservation Project. The San Diego Pilot Project was designed primarily to test three methods of distributing the water saving kits. Approximately 180,000 water saving kits were distributed through three methods:

- Mass Distribution. Delivery of kits to each household in the area by a private delivery service. No attempt was made to contact the residents during delivery. The kits were hung on door knobs.
- Door-to-Door Distribution. San Diego area Boy Scouts and other volunteers delivered kits in this sector. Rather than placing the kits at every household, the kits were handed to household members. If no one was home, a card was left which indicated where a kit could be obtained.

- Depot Distribution. Approximately thirty centrally located points in the region were established as water kit depots. Residents of selected zip code areas were asked to pick up their kits at the depots.

Copley International Corporation. Follow-Up Survey: Household Usage Test for Five Brands of Water Conservation Kits. Copley International Corporation, La Jolla, California, June 1977. 37 p.

44 - This report summarizes the findings of a follow-up survey of some 300 San Diego households selected for participation in a product test program for the Department of Water Resources. The results present data on removal of devices, long-run acceptance and general comments on performance of toilet dams and shower flow reducers.

Crisp, J. and A. Soboler. "An Investigation of the Performance of Lavatories Using Spray Taps, and of Sanitary Accommodations in an Office Building." Journal of Institute of Water Engineers, 13:513-575, 1959.

45 - This is a British study on installation of spray taps in office building lavatories. Conclusions show 1/3-1/2 reduction in water used per day. An investigation carried out in an office building showed that if wash basins are fitted with spray-taps, the consumption of water for washing is reduced by a half. The paper gives figures for the frequency of usage of wash basins and W.C.'s, its variation during the day, and indicates how the recorded water consumption of 10.7 g.p.d. can be reduced by 30 percent.

Davies, Dale and Bruce Haines. Some Political-Institutional Factors Affecting Efforts to Conserve Water in Washington State, Washington State University, Washington Water Research Center and Department of Political Science, June 1978. 71 p.

46 - The extent to which administrative mechanisms are adopted and successfully implemented depends in part on support and opposition from water users and those who represent them. In this study relevant perceptions and attitudes of individuals interested and/or influential in Washington state water policy were surveyed by means of a mailed questionnaire.

Most respondents agreed that water was becoming more scarce, and the principal causes of scarcity were felt to be insufficient precipitation, deficient storage, inadequate monitoring, lack of governmental planning and regulation, and wasteful practices by agricultural, municipal/domestic and industrial users. Respondents were most supportive of proposals to (1) institute voluntary programs for improving conservation, and (2) impose negative incentives on users who waste water. The least support was given to proposals for positive incentives to encourage more efficient practices.

Attitudes and perceptions of respondents from non-profit, development-oriented associations were closer to those of state officials than to the profit-makers whom they represented. This finding suggests that efforts to promote conservation may be more effective if associations of water users are encouraged to participate more actively in them.

Denver Water Department. 44 Ways to be Waterwise. Denver, Colorado.

47 - Tips for saving water in the bath, around the house, when landscaping, and on lawns and gardens are listed. It includes types of plants with low-water requirements and suggested cutting lengths for a few types of grass.

"Conservation, Care and Control of Water." Domestic Engineering, July 1978.

48 - The emphasis of the Plumbing Manufacturers Institute is conserving water at the point of use--through flow restricting showerheads and aerator-type faucet attachments. Their standard establishes a rated minimum flow rate for sink faucets and showerheads at 2.75 GPM. The standard also provides a recommended test procedure which will permit independent agencies to conduct tests in a standardized manner so that results will be comparable between agencies. No standard is available yet for proper performance of water closets with reduced water consumption.

"Water Can Be Conserved in Showers: But Consider the Safety Factor." Domestic Engineering, July 1977.

49 - Contractors must consider safety when installing watersaving devices to guard against water temperature extremes. A change in water flow which makes a bather uncomfortable at 6 GPM will scald the bather if he/she is using a low-flow showerhead of 2 GPM. Therefore, flow controls should be used in conjunction with safety type shower valves as part of a properly designed shower system.

East Bay Municipal Utility District Offices. Conservation Is Something You Can Do. Oakland, California. 4 p.

50 - This small brochure describes how to install a water dam in a toilet and how to install a water-reducing showerhead in the shower. Since conventional toilet tanks use 3.5-6 gallons per flush, and most showers use from 4-10 gallons per minute, reducing water use in these two areas can be an important aspect of water conservation.

East Bay Municipal Utility District. Some Rather Unusual Ideas For Saving Water. Oakland, California, 1977. 18 p.

51 - This booklet provides an extensive list of suggestions on ways to save water inside and outside the home. Many of the suggestions include water-saving devices and tips, many of which are highly unusual. The areas covered include ways to wash, clean, cook and drink; the use of the toilet; watering the lawn; and pursuing other daily activities using less water.

East Bay Municipal Utility District. Water Conservation Today and Tomorrow. Oakland, California. 13 p.

52 - This booklet discusses general water-conserving tips for homeowners applicable to both indoor and outdoor water uses. Areas discussed include how to use less water per flush, toilet maintenance, showers, how to fix leaky faucets, kitchen and laundry tips, and garden and outdoor water use reduction tips. It also provides a brief overview of a few water-saving devices.

Ecological Analysis, Inc. Water Supply Study for Montgomery and Prince Georges Counties, Maryland. October 1977.

53 - Washington Suburban Sanitary Commission's (WSSC) evaluation/publicity program and plumbing code changes resulted in water reductions from 13%-26%. For the WSSC, a request of no outside water use and appeals for conservation achieved a decrease of from 11%-39%, depending on various factors. It is projected that banning all outside water use, creating a crisis atmosphere and lowering system pressure could achieve reductions of from 19% to 50%.

"A Chicago Suburb Conserves Water." Environmental Management, 5-6, Aug. 1978.

54 - In its effort to reduce water consumption by 15%, the city of Elmhurst, Illinois developed an ambitious public awareness program. The program included:

- a media blitz informing residents of the problem;
- development of a newsletter;
- changing water rate structures;
- modification of plumbing codes to require that all new plumbing fixtures comply with minimum standards;
- distribution of displacement dams and showerhead attachments;
- limiting outdoor water use.

Although results are preliminary, so far they are very encouraging.

Farallones Institute. Gray Water Use in the Home Garden. Berkeley, California, 1977. 11 p.

55 - This brochure answers some of the most commonly asked questions concerning the use of household wastewater for garden irrigation. The order of preferred use for gray water sources is: bath/shower water, bathroom sink, washing machine, utility sink and kitchen sink water. The brochure also explains precautions to be taken to protect against damage to the soil resulting from long-term use of gray water.

Fehrm, A. "Saving Water Safely With Shower Controls: Special Water Conservation Report." Domestic Engineering, 1978/79.

56 - To protect the consumer at home, the proper jurisdictional plumbing code should mandate that all shower/bath controls be of the safety type to protect against water temperature extremes. The average cost differential between a conventional control and a safety type control is in the range of $5 to $25. The temperature change problem is eliminated when safety-type showers are used. Because of their basic function of controlling to a fixed temperature, pressure-balancing on thermostatic valves are not unduly affected by the installation of a flow-restricted 3 GPM showerhead.

Feldman, Stephen L. A Handbook of Water Conservation Devices. Applied Science and Research Applications, National Science Foundation, Washington, D. C., Nov. 1977. 79 p.

57 - Current water supply problems and projected near future shortages in the United States have created interest in methods of reducing domestic water demand. The techniques included in this handbook include education of consumers to alter their water using behavior, metering, pricing, and/or installation of water-saving devices. Devices included are: (1) water-saving toilets and accessories, waterless toilets, bidets, and urinals; (2) flow limiting devices for faucets and showers; (3) alternative plumbing systems; (4) domestic recycling systems; (5) piping insulation; (6) dishwashers and clotheswashers; and (7) lawn and garden irrigation control systems. A description of each type of device is followed by a list of manufacturers of that device, and any special details that may pertain to their particular versions. The handbook is intended to guide consumers in product identification and selection.

Finkelstein, Hal. "Water Conservation: A Major Energy Saving Technique." Building Systems Design, 71(7):37-38, June-July, 1974.

58 - Written for owners and engineers of buildings, this article outlines construction and operation cost savings that are available when water conservation techniques are utilized at the design stage and details where the actual savings lie in building operations. When using methods to restrict hot water use, including spray faucets and low-flow showerheads, a multiple dwelling will save 30% of the energy that would normally be utilized for domestic hot water. In New York City, for example, utilization of water conserving devices could save 125 million gallons of water per day, obviating the need to build one new large reservoir. The water conserving devices would, thereby, save the city $28 million per year.

Fletcher, P., and W. Sharpe. "Water Conservation Methods to Meet Pennsylvania's Water Needs." American Water Works Association Journal, Washington, D. C., Nov. 1977. 79 p.

Various water-saving devices are discussed, and it is concluded that many are cost-effective, including shower flow controls, toilet inserts, and dual-cycle modifications for toilets--all designed for retrofit operations in existing housing. Water-saving toilets appear to be cost-effective in new construction. There is also some evidence that bath and laundry water recycle systems are cost-effective in homes experiencing periodic on-site disposal-system malfunctions. The rising demand for cost-effective and environmentally safe on-lot sewage disposal alternatives will lead to new technological developments employing water-saving devices. As new products and techniques become better known in the plumbing trade, their costs, especially for water-saving toilets, should decrease. For new construction in much of rural Pennsylvania, water conservation with water-saving devices seems the best approach in the decades just ahead.

Fowell, Andrew J., et al. "Water and Water Related Conservation in Buildings." Water Supply and Drainage in Buildings, Department of Commerce, National Bureau of Standards, Washington, D. C., 21-30, Aug. 1979.

60 - This is a presentation of an international symposium on water supply which briefly outlines the nature of water supply in the U.S. The report also outlines current usage statistics and projects potential savings realized through two alternate conservation scenarios.

Fulton, W. "How Elmhurst Cut Water Use." Innovations, 2(2):6-8, Jan. 1978.

61 - A multimedia blitz made Elmhurst, Illinois residents aware of the water supply and sewage treatment problems. The program cost approximately $1.00/capita, and has been very successful. It cut water use by 15%, increased existing sewage capacity by 4,800 people, and saved $400,000, which the city had planned to use to build a deep well.

Gay, D. E. "Spray Faucets Save Water and Energy." Plumbing Systems Design, 71(4):35-36, June-July 1974.

62 - The spray faucet is an effective device for conserving water; it uses only 0.5 GPM as compared to the traditional basin faucet which uses about 3.0 GPM. Spray faucets save about 55% of the hot water normally used by traditional faucets. Depending on the initial cost of the faucets, the pay-back period varies from two to ten months.

Gilbert, J. B. and Associates. Water Conservation Reuse and Supply, 48 p.

63 - The San Francisco Bay Area water conservation program is described, including the conservation education program, devices used, and the way in which different counties in the area responded. Some of the programs discussed include consumer education, retrofit device programs, programs for new construction, metering and pricing. A chart of water conservation elements and potential savings and costs is provided.

Graf, R. and G. Whalen. "Programmed Watering." *Popular Mechanics*, 92, July 1977.

64 - Underground water sprinklers allow watering only when needed. In such a system, pipes buried below the lawn are fitted with sprinkler heads at strategic locations. The pipes are attached to valves that are activated by a controller which the homeowner can program. Residential underground sprinklers cost from $600 to $1,200.

Grear, Michael James. Residential Water Conservation: The Suburban Maryland Experience 1970-1975; *Proceedings; Conference on Water Conservation and Sewage Flow Reduction with Water Saving Devices*, Pennsylvania State University. U.S. Department of Commerce, NTIS PB 250 999, July 1975. p. 1-22.

65 - The Washington Suburban Sanitary Commission is a state chartered bi-county public utility which provides water and sewer service for over 1.2 million individuals living in a 1,000 square mile section of Suburban Maryland. In May of 1970 the WSSC found itself facing two major crises: A potential water supply shortage, and a State Board of Health "sewer moratorium" due to the lack of treatment capacity in local sewage treatment facilities. These two crises, plus a genuine interest in the improvement of the natural environment, in helping people to help themselves to conserve water and energy, use water wisely, eliminate wastage and reduce water and sewer bills, led to the creation of a Water Conservation/Wastewater Reduction/Customer Education Program.

There have been quite a few large and small projects within this Water Conservation/Customer Education Program during the past five years. Some have paid handsome dividends in reduced water consumption and sewage flows, others have not produced measurable results.

Some of the larger projects include: The assembly and distribution of a Water Conservation Handbook; a water conservation device test project covering 2,400 homes in the Cabin John, Maryland area; the distribution of 300,000 toilet displacement "Bottle Kits" and leak detection pills; the distribution of free shower flow control devices and the assembly of a 20 minute water conservation film entitled "Drip."

Griffith, F. I., Jr. "An Equitable Rate Structure Relation to Conservation and Wastewater Flow Reduction", Nov. 1978.

66 - This paper describes Fairfax County Water Authority's development and design of a rate structure that attempts to maximize the economic and conservation benefits of the potential demand reduction elasticity by concentrating on the peak season use. The paper concludes that unless a community is ready to live with unrealistically high and probably unjustifiable water and sewage rates, it will be working with approximately a 5% elasticity factor for total annual demand.

Hamilton Township, New Jersey Department of Public Works. Water Conservation Program, January 1978. 6 p.

67 - In an effort to extend the treatment capacity of its already overloaded sewage treatment plant, the Township of Hamilton, New Jersey, has undertaken an unusual water conservation program. Through the distribution of water-saving showerheads and toilet partitions, the Township hopes to save 2 million gallons of water a day. After implementation, 65% of the respondents were using their aerators and found them to give acceptable showers, and 51% were using their toilet tank partitions. The project on a whole seems to be successful on a short-term basis, and in time, the Township should get a substantial return on the capital expended for the project.

Hanke, Steve. "Some Behavioral Characteristics Associated with Residential Water Price Changes." Water Resources Research, 6(5):1383-1386, Oct. 1970.

68 - This article describes how residential customers reacted to the installation of meters. Of those sampled, 48% indicated they had increased water conserving activities since metering. The major types of response in order of sample frequency were: (1) watching sprinklers more carefully; (2) ceasing to sprinkle parts of the yard; (3) permitting the yard to turn brown; (4) watering at night; and (5) repairing outside leaks. The conservation practices of 58% of the sample intensified over time, as consumers learned how to make substitutions and use water more efficiently.

Hanke, Steve. "Water Rates: An Assessment of Current Issues." American Water Works Association Journal, 215-219, May 1975.

69 - Rate-making, which was once a relatively inactive function within a water utility's operations, has become a very active function. With rising costs, utilities are revising rates regularly to obtain increased revenue. Also, consumer groups want to encourage low-usage through price incentives, and environmental groups favor utility rate modifications to encourage water conservation. New rate structures that reflect temporal and spatial variations, seasonal and zonal fluctuations, and impose a surcharge for water used above a certain base rate may be more equitable, and encourage conservation. This would increase the

efficiency with which resources in the water sector of the economy are used.

"Emerging Markets: Water Savers." Hardware Retailing, 133(3):76-77, Sept. 1977.

70 - As consumer awareness increases, water-saving products will sell increasingly better. This article makes retailers familiar with some of the merchandise available on the market. These items are very promotable. Promotion is very important since consumers must be made aware that they can cut water consumption in half, and that the merchandise will pay for itself in a few months.

Herr, L. A., M. B. Sonnen, P. L. Thompson, Co-Chairmen. Proceedings; Conference on Water Conservation Needs and Implementing Strategies, Washington, D. C.; Urban Water Resources Research Council, American Society of Civil Engineers, July 1979. 138 p.

71 - This conference was directed at water conservation needs and implementing strategies. In talking of water conservation, two major aspects are defined. The first of these is the attempt to achieve permanent changes in water use habits through various conservation incentive programs. The second aspect is development of contingency programs for periods of drought or low flow. It is on this latter aspect that the conference focuses, examining many instances of drought nationwide and the strategies that were implemented at the time of, and in response to each.

Hoffman, M., R. Glickstein, and S. Liroff. "Urban Drought in the San Francisco Bay Area: A Study of Institutional and Social Resiliency." American Water Works Association Journal, 71(7):356-363, July 1979.

72 - In San Francisco's successful conservation program, water rationing was extremely important. One reason managers were successful was because they considered the fairness of the rationing program a higher priority than the ease of implementation. Equity and public perception of rationing programs are very critical in terms of public participation. Furthermore, most customers prefer fixed allotments where they can determine their own priorities rather than being told how to use their water.

Idaho Soil Conservation Commission, U.S. Department of Agriculture. Water Conservation Tips for Stretching Water for Yards and Gardens, February 1977.

73 - This brochure lists many ways to keep yards and gardens green while using less water. It points out that plants differ in the amount of water they need and that this varies with climate and changing weather conditions. It lists alternatives to conventional watering, such as saving water for vegetable gardens, annuals and other plants that won't survive well without water. It also describes how to apply water efficiently by watering slowly, and early in the morning. Moisture can be conserved by using mulch and not mowing grass too short.

Illinois Department of Transportation, Division of Water Resources. Wise Meter Use: A Curriculum Supplement for Teachers.

74 - This booklet provides four curriculum guides for grade levels K-12 dealing with:

- water conservation tips;
- wastewater treatment processes;
- how to inspect for leaks;
- how the government addresses water conservation problems through a variety of agencies.

Illinois Interagency Water Management/Conservation Commission. Don't Let Your Toilet Waste Water. 1 p.

75 - This fact sheet describes how to determine if a toilet is leaking and how to fix it. Dye pellets are attached to the sheet to aid in detecting a leak. Most frequently, leaks in toilets are caused by a defective flush valve, which is a flap or ball plunger device that is supposed to act as a stopper in the bottom of the toilet tank. Installation of an inexpensive replacement valve or a complete replacement kit will repair these leaks.

Illinois Task Force on Drought. Drought in Illinois. Springfield, Illinois, March 1977. 47 p,

76 - The report states the causes, extent and effects of the 1976-1977 drought, details the emergency measures, short and long-term solutions, and attempts to disseminate these findings to state and local governments and to the public. It includes a chart of potential residential water savings and water savings as a percentage of total indoor use. It also presents a discussion of local, state, and federal funding possibilities.

Lorkin, D. G. "Economics of Water Conservation." American Water Works Association Journal, 470-474, Sept. 1978.

77 - The costs of mandatory water conservation to the East Bay Municipal Utility District in 1976-77 are detailed. Since most water utility costs are fixed, revenues do not vary significantly with the amount of water sold. Therefore, any loss in revenues due to conservation must be made up by increases in water rates. Customers accepted higher water rates during the drought. However, a citizen's committee has been appointed to review the rate structure before another rate increase is implemented in 1979.

Lattie, J. "Public Education for Water Conservation." Community Water Management for the Drought and Beyond: A Handbook for Local Government, California Governor's Office of Emergency Service, Sacramento, California, July 1977. p. 46-58.

78 - This article stresses the importance of effective public information in water conservation programs. Program elements include direct mail of an insert or handbook using the news media, making personal contacts, the use of special events, and the development of other materials. The price range for carrying out a short-term crisis program or setting up a long-term program can start at $500 to $1,000. Total short-term or annual program costs for a community of 25,000 residents could range from $2,000 to $15,000, depending on the number of program elements used.

Lawson, C. "Techniques for Saving Water in Homes and Businesses." Community Water Management for the Drought and Beyond: A Handbook for Local Government, California Governor's Office of Emergency Service, Sacramento, California, May 1977. p. 63-70.

79 - This article lists water saving techniques that have been tried in California for toilet water savings, bath/shower/sink savings, kitchen savings, laundry savings, landscape water savings, and other outdoor savings such as washing the car and driveway. Business water savings include serving water only upon request in restaurants, turning off fountains, and reduced water use for cleaning and maintenance. Some potential problems have been presented such as toilet bottles floating and toilet dams not fitting. A chart on how much water various conservation tactics save is presented.

Marsh, A., et al. Drip Irrigation. Leaflet #2740. University of California, Division of Agricultural Sciences, Sept. 1975. 4 p.

80 - Drip irrigation, which can use up to 50% less water than other methods of irrigation, is discussed. The amount of water applied should be based on measured or carefully observed soil-water conditions that reveal the balance between additions and withdrawals. Possible problems and operational requirements of drip irrigation are discussed.

McGhee, R., M. Reardon, and A. Shulman, Eds. Readings in Water Conservation. National Association of Counties Research, Inc., Washington, D. C. 332 p.

81 - This anthology presents a series of articles and comments designed to acquaint the reader with the great range of issues surrounding the topic of water conservation. It is intended to be introductory rather than exhaustive. Section one presents the federal laws and regulations pertaining to water conservation; it also includes a representative sample of local ordinances and one state law which promotes conservation. Section two reviews briefly the hardware of water conservation and potential savings from each type. Section three details the components of a public education program which may be run by a water utility or local government. Section four addresses a broad array of economic, management and planning issues which arise from efforts to conserve water or alter water use patterns. Section five is a case study of the water conservation program developed by the city of Westminster, Colorado.

McLaughlin, Everett R. A Recycle System for Conservation of Water in Residences; Proceedings; Conference on Water Conservation and Sewage Flow Reduction with Water Saving Devices, Pennsylvania State University. U.S. Department of Commerce, NTIS PB 250 000, p. 133-172.

82 - Water used in residences performs various functions which have different requirements for initial purity and result in different degrees of contamination. A study of the average use of water reveals that the water may be used more than once in a cascade system. Primary water may be used for laundry and the resulting secondary water may be used for flushing the toilet. Since the primary and secondary uses are at different rates, a storage facility is required, as is a pump for pressurizing the secondary water. Observations over a year show that a near balance can be attained between the two uses and that approximately 30 percent of the water used can be recycled. This is a net saving of 23 percent of the primary water that would be used if the system were not in operation. Maintenance requirements are relatively minor. The primary advantages of the system are reduced water requirements and reduced disposal requirements. A relatively long amortization period would be required, although proper sizing of the equipment would reduce the initial cost to a minimum.

Marin Municipal Water District. "Marin Life Line." Newsletter, 8 p.

83 - A rationing program was implemented during the drought with the goal of reducing water use by 57%. Tips, devices, how to read one's water meter, how to use reclaimed wastewater and gray water and reduce outdoor water use are the topics discussed in this newsletter. A chart of billing procedures and water rates in Marin County is provided.

Metcalf & Eddy, Inc. Water Savings. Metcalf & Eddy, Inc., Palo Alto, California, May 1976. 180 p.

84 - The purpose of this report was to identify the various water-saving methods and to evaluate them in terms of effectiveness, costs, ease of implementation, and public acceptance. The results were used to form a recommendation for the implementation of the district's water conservation program.

The scope of this report included the following elements:

- a summary of the water use pattern in Santa Clara County, including residential, commercial, industrial and agricultural uses;
- a survey of the water-saving methods available to domestic, commercial, industrial, and agricultural users;
- a survey of the water conservation programs implemented by other utilities in the nation;
- an assessment of the effectiveness of various water conservation methods in Santa Clara County;

- an assessment of the impact of water conservation programs on water consumption, wastewater collection and treatment, and public acceptance;

- recommendations for general approaches to be taken for the implementation of a water conservation program in Santa Clara County.

Milne, Murray. Residential Water Conservation. California Water Resources Center, University of California, Davis, California, March 1976. 468 p.

85 - This is intended to be a non-technical report for homeowners, builders, developers, architects, planners, utility company managers, plumbingware manufacturers, and lawmakers who are seeking ways to reduce residential water consumption. A "typical" residential consumption profile is presented, along with a brief history of how water has been used in the home. Water conservation is not simply a matter of inventing new fixtures; in fact there are four types of constraints which must all be satisfied before any innovation in water conservation can be implemented: Economic, institutional, sociocultural, and technological. The impact of each of these factors is discussed. Over four dozen commercially available devices which affect water consumption in the home are evaluated. In an attempt to discover future trends, a survey was made of the relevant aerospace technology, including Apollo and Skylab systems, as well as the systems installed in commercial jet aircraft, trains, and ships. Recent patent applications were searched and dozens of new water-conserving fixtures and appliances were discovered. Four scenarios are laid out to show the homeowner different strategies for reducing water consumption. Finally a series of recommendations is made defining specific actions that can be taken by utility companies, lawmakers, and plumbingware manufacturers to reduce residential water consumption. The Appendix contains a 250-item annotated bibliography and a directory of manufacturers.

Montgomery, Charles E. Water Savings with the Save-It Water Saver; Proceedings; Conference on Water Conservation and Sewage Flow Reduction with Water Saving Devices, Pennsylvania State University. U.S. Department of Commerce, NTIS PB 250 999, July 1975. p. 173-174.

86 - The report summarizes a series of tests on a water-saving device that fits around the flush valve in the toilet tank--The Model No. SA-720 Watersaver. When the toilet is flushed, the water in the tank is channelled into a smaller vertical area, producing more top pressure or momentum, and therefore allowing for a complete flush, using 30 to 40 percent less water or about 2 to 2½ gallons. The Environmental Protection Agency states that 36-45 percent of the water used in homes results from toilet flushing and that an average family of 3.3 uses approximately 42 percent or 881 gallons of water per week, just for flushing the toilet. Today, if one of these water savers were installed in every toilet tank in the U.S., it could save about 2 1/3 billion gallons of fresh water every day, or about 850 billion gallons of water per year.

Moses, Hal L. Research on Water Saving Devices at Virginia Polytechnic Institute and State University; Proceedings; Conference on Water Conservation and Sewage Flow Reduction with Water Saving Devices, Pennsylvania State University. U.S. Department of Commerce, NTIS PB 250 999, July 1975. p.117-132.

87 - This paper describes some basic research on water saving devices and the development of a simple but effective flow control that can be used with conventional showers and faucets. Flow characteristics, including cavitation of typical fixtures and orifice or nozzle-type flow controls, are described along with an approximate analysis. Possible flow instabilities and noise associated with the devices are discussed and some experimental results are presented.

Muller, John George. The Potential for Energy Savings Reductions through the Use of Flow Reducing Devices and Other Conservation Measures. Federal Energy Administration, Washington, D. C., November 1976. 55 p.

88 - This presentation of data reported in other studies deals generally with use and potential savings from flow restrictors. Some mention is made of aerators and spray valves. Mention is also made of the human factors involved, including length, temperature, and frequency of showers. A worksheet for energy savings due to flow restriction is included.

National Bureau of Standards. Sewerless Devices Evaluation Basis: Interim Compilation and Rating Letter Report. U.S. Department of Housing and Urban Development, Washington, D. C., Sept. 1979. 7 p.

89 - This compilation and evaluation of wastewater disposal devices included the following activities:

- literature search;
- contacts with manufacturers and sales representatives;
- exhibits in institutes and conference halls;
- field trips and observation of devices in actual use.

The limited number of similar installations available for evaluation and the various advanced technologies applied to wastewater disposal constrained the study within the time period allowed. A larger study will be conducted to establish a substantiated data base for sewerless devices evaluation.

Nelson, J. "Moving from Water Conservation to Water Management." Community Water Management for the Drought and Beyond: A Handbook for Local Government. California Governor's Office of Emergency Service. Sacramento, California, May 1977. p. 70-77.

90 - This article discusses the principal components of water demand management, which are: Water metering, pricing policies, consumer education, and water saving devices and techniques. Water savings of 13% for single-family units can be achieved with an investment of $35-$40, while a 30% water savings can result in an apartment for an investment of $176. It concludes that water savings of 10% in domestic use are relatively easy to achieve. Savings of 50-60% can be achieved, but only with substantial hardship and adverse economic impact.

Nelson, John. Northern California Rationing Lessons.

91 - The Northern Marin County Water District implemented water rationing during the drought in 1976. This article discusses how consumers responded to the rationing. In the West, where irrigation makes up as much as 50% of annual domestic water requirements, rationing can result in a 25-40% reduction in water use.

Nelson, John Olaf. Water Conservation, Here We Come! Presented at 7th Annual Lake Tahoe Seminar on Wastewater Treatment and Reuse, November 1978. 26 p.

92 - Principal elements in water conservation programs, including consumer education, water metering, pricing, devices, appliances, lawn and irrigation techniques and regulation are described. Estimates are given for the water savings potential of each. A reasonable consumer education program would consist of the following: Classroom water conservation materials, bill stuffers on conservation, purchase and loan of water conservation films. Also, utility managers or other public officials can readily volunteer to speak on water conservation. Energy savings for reduced domestic hot water use were estimated. The annual energy savings attributable to use of shower devices for a family of 3.5 people is about $7.50.

North Marin County Water District. North Marin's Little Compendium of Water Saving Ideas. Novato, California, March 1977. 273 p.

93 - This book is an extensive, non-technical discussion of residential water-saving ideas, techniques and methods. The report includes a detailed bibliography and a cross-referenced list of manufacturers of water-saving devices, such as faucet flow control devices, insulation for hot water pipes, pressure regulating devices, shower flow control devices, reduced water toilet devices and systems, and lawn and garden irrigation controls. Other than devices, water conservation alternatives include consumer education, water metering, water pricing, water saving appliances, lawn and garden irrigation techniques, low-water use landscaping, and mandatory regulation.

Palla, Robert L., Jr. Evaluation of Energy Conserving Modifications for Water Heaters. U.S. Department of Commerce, National Bureau of Standards, Washington, D. C., July 1979. 42 p.

94 - The effects of various energy-conserving modifications on water heating energy consumption were evaluated based on laboratory tests. Nine storage-type residential water heaters, representative of standard and "energy-saving" electric, gas, and oil fueled models currently on the market, were obtained for testing. Federally-promulgated water heater test procedures were used to measure the energy consumption of each unit before and after modifications. Energy-conserving modifications and corresponding projected reductions in energy consumption included: Reduced thermostat settings (10°C); 12 percent savings for standard electric, gas, and oil fueled water heaters (where appliance performance does not degrade below an acceptable level, and water heater capacity is still sufficient to meet hot water needs); improved insulation, and 9 percent savings for all water heater fuel types. Also considered for gas-fired units were reduced pilot input rate from 220 W to 60 W (750 Btu/h to 200 Btu/h) - less than 2 percent savings; use of thermal dampers - 3 percent savings; use of intermittent ignition - 5 percent savings; and use of intermittent ignition and mechanical flue dampers - 11 to 16 percent savings. Modifications to energy-saving models resulted in somewhat smaller reductions. Multiple modifications were found to offer energy savings slightly less than the sum of the individual savings.

Palla, Robert L., Jr. The Potential for Energy Savings with Water Conservation Devices. U.S. Department of Commerce, National Bureau of Standards, Washington, D. C., NSBIR 79-1770, July 1979.

95 - With the use of residential water saving devices, substantial decreases in water consumption may be realized. Perhaps of even greater significance, however, are the resultant reductions in water-related energy requirements--for water supply, wastewater treatment, and water heating. Through a survey of water-related energy use, a relationship between water usage and energy consumption is developed. Results obtained indicate that energy requirements for water heating far exceed those for water supply and wastewater treatment. Based on estimates of residential water consumption with and without water conserving products, the potential for energy savings is assessed. Reduction in household water heating energy consumption of about 35 percent are predicted with the use of "conventional" water saving products. Also considered in this study are the energy saving potentials of grey water recycling and grey water heat recovery systems.

Palla, Robert L., Jr. A Product Class Evaluation of Domestic Water/Energy Conservation Systems and Devices. National Burea of Standards, Center for Consumer Product Technology, Washington, D. C., October 1978.

96 - At the request of the National Bureau of Standards Office of Energy Related Inventions (OERI) a study of energy use in water supply, water treatment, and residential water heating was undertaken by the Product Performance Engineering Division at NBS. Also conducted was a survey of state-of-the-art water and water-related energy saving devices. It was the purpose of this study to provide guidance, data, and material for use by OERI in evaluating inventions within this class in terms of energy savings, and in identifying those inventions or devices which warrant Department of Energy (DOE) support. Worthy devices would be those that offer substantially greater energy savings than currently available state-of-the-art devices.

Park Forest Recreation and Parks Department of Bloom Township. Conserving Water in the Landscape: The Green Scene. 2 p.

97 - This small pamphlet lists tips to reduce water use in lawns and gardens, and ways to keep lawns healthy. Trees and shrubs should be watered slowly, deeply and infrequently. Preparation and maintenance of the soil is the most important aspect in maintaining a quality lawn and conserving water during irrigation. Important soil qualities are soil structure, grading, moisture content, and soil density.

Pennsylvania State University. Water Conservation and Waste-Flow Reduction in the Home. Special Circular #184. 9 p.

98 - This article explains why conservation is important and how conservation saves money. A detailed discussion is presented on the water cycle--where water comes from, how it is treated and what happens to it after it leaves our homes. Also described are many different water-saving devices and methods, such as water closet inserts, faucet aerators, spray taps, flow control devices, improved float assemblies, shallow trap toilets, two-cycle toilets, recycling wastewater, vacuum systems, incinerator toilets and low water-use dishwashers and clothes washers. For each device or method, cost estimates of the net savings per year for a family of four are given.

"Impact of Water Saving Water Closets on Building Drains and Sewers." Plumbing Engineer, November-December 1977. 20 p.

99 - This report concludes that not enough is known about the use of water-saving water closets, and more research needs to be done. Theoretical indications are that the utilization of water-saving water closets should not cause problems in the building of drains and sewage collection systems. The study also points out that water demand is relatively inelastic and that only massive price increases will significantly reduce usage. A promising rate approach is peak level pricing, or charging significantly more for use above a certain level during periods when demand is the highest. This is designed not to raise additional revenue, but to reduce overall consumption.

Plumbing Manufacturers Institute. How to Sell Water/Energy Conservation Products, 1977. 30 p.

100 - This article has suggestions, guidelines, and materials for plumbers to help them sell water conserving devices and check water conserving features in households. The heart of PMI's suggested program is a water/energy conservation safety audit. A checklist is provided for plumbers to check the bathtub/shower, lavatory, water closet, kitchen sink, water heater, washing machine, water softener, distribution/service, laundry tub, sillcocks, sprinkler systems, and pumps. On the audit, the plumber can indicate what condition these are in, what it would cost to repair it, if necessary, and probably cost savings per year. Homeowners can then decide whether they want the job done. Procedures for promoting the audit are also suggested.

Powell, Evan. "PS Tests Bathroom Water-Savers." Popular Science, 211(2):120-122, 147. Aug. 1977.

101 - Popular Science tests, essentially subjectively, a number of bathroom water-saving devices for shower and toilet. Shower modifications included water-saving showerheads and flow control washers. Tests suggested that all shower water-reducing washers were worthwhile and if replacement was warranted or even desired, the flow-reducing showerheads were a very good, and relatively inexpensive investment (both simple and dual flush). Toilet dams and tank inserts were tested. The simple dam was found to flush better than a regular toilet. Dual flush was difficult to install and not as effective. Inserts of bricks or other displacement objects were mentioned as undesirable, and water-saving and waterless toilets were expensive and warranted only if replacement was mandatory. Water-reducing faucets were recommended also if replacement was needed.

Raabe, R. D. "Some Approaches to Water Conservation in the Garden." Pacific Horticulture, Fall, 1977.

102 - There are many ways to save water in the garden. Hand watering is much better than ditch irrigation or overhead sprinklers because the water can be put where it is needed. Drip irrigation systems are excellent for conserving water and can also be used to water individual plants. Plants with low water requirements are listed. In general, the larger the plant, the larger the root system available to explore for water, and the less watering required. Removal of weeds is also important. Organic materials such as leaf mold, decomposed manures, or compost can be worked into the soil. Finally, grey water should be saved and used whenever possible.

Ramey-Smith, Ann and Jennifer L. Gaguon. An Investigation of Preferences for Various Types of Energy Cost Feedback. U.S. Department of Commerce, National Bureau of Standards, Washington, D. C. February 1979.

103 - This study addressed the issue of consumer preferences for various types of energy cost feedback for individual consumers. Its purpose was to provide human factors recommendations to DOE related to the performance characteristics of energy cost feedback meters. Simulation and interview techniques were used to provide consumer reaction to cumulative, instantaneous, and projected feedback presented as dollar and cent values. A majority of participants indicated a preference for cumulative feedback types. All types of cumulative feedback are easily understood, accurate in reflecting actual energy consumption and suitable to several uses. Hourly instantaneous feedback was considered useful for monitoring energy use of individual appliances. All participants having two energy sources in their home expressed a preference for having feedback presented as separate cost figures rather than as a total cost. Recommendations for feedback types as well as some performance characteristics of energy cost feedback meters for further testing by DOE are discussed.

Reid, G. W. et. al. An Exploratory Study of Possible Energy Savings as a Result of Water Conservation Practices. University of Oklahoma, Norman, Oklahoma, July 1976. 132 p.

104 - The objective of this study is to evaluate energy consumption from the use of various alternatives of water conservation practices. The amount of water saved from each alternative is first calculated. Then, from each of these potential water savings, the amount of energy involved and the economical effect of each alternative can be determined.

This study includes comparisons of eighty-one possible household water conservation devices and reuse systems with conventional water use methods and comparisons of flow reduction from residential uses as results of the alternatives. Total monetary savings in energy of each alternative, associated with pumping, heating, transmission and operating for water production and wastewater treatment are compared with the total monetary savings in water of the water-saving devices. The report concludes with a cost-effectiveness analysis and the ratings of the conservation alternatives in terms of both energy and water saved.

Resources. Handbook for Community Water Management. May 1977.

105 - This handbook is written for local government officials to help them solve drought-related problems using "demand management." The major components of "demand management" are:

- water metering;
- pricing policies;

- consumer education;
- water-saving devices and techniques.

Savings can vary from 10% to 60%, but increasing hardship and adverse economic impacts result from reductions of over 40%.

Rice, I. M. and L. G. Shaw. "Water Conservation: A Practical Approach." American Water Works Association Journal, 480-482, Sept. 1978.

106 - Dallas, Texas is trying to encourage water conservation by changing the residential water rate structure. The approach used involved imposing a surcharge for monthly water consumption above a specified level during the summer months. The results of the first summer's experience, although preliminary, were extremely encouraging. According to these preliminary results, the new pricing policy may have presented the Dallas system with the equivalent of a 50-75 mgd treatment plant at no cost.

Schatzberg, Jackson, Kelly, and Harris. Energy Conservation Through Water Resource Management: A Reduced Flow Bathing Shower. Naval Ship Research and Development Center, Annapolis, Maryland. In-house article, not referenced. p. 141-146.

107 - This is a study of reduced flow showers--air assist--aboard ships to conserve potable water. The study points out "in bathing with a shower, water must penetrate the boundary layer of the skin to permit wetting down, soaping up, and rinsing off. In a conventional shower, the motive force to achieve this comes from the water pressure, which provides the spray droplets with the necessary kinetic energy. In the RF shower, this motive force is supplied by the air from the blower."

Tests proved very successful. Average water consumption per shower was reduced from 12.1 to 1.7 gallons. User acceptance surveys showed 90+% willing to use this type of shower on board a ship; 90% felt they could get sufficiently clean using an RF shower; and 63% would be willing to use such a shower at home. Based on cost of distilled water (shipboard use), units were seen to repay costs of installation in two years.

Sharpe, William and Peter Fletcher. The Impact of Water Saving Device Installation Programs on Resource Conservation. Research Publication 98. The Pennsylvania State University, Institute for Research on Land and Water Resources, University Park, Pennsylvania, July 1977. 44 p.

108 - This is an extensive survey of participants in the Washington Suburban Sanitary Commission Program and plumbers. Public acceptance is discussed in depth. Some water use/demand information is presented as well as a short discussion of plumbing codes and effects. The program focuses on toilet inserts and shower flow reduction.

Sharpe, W. and M. Grear. "An Evaluation of the Washington Suburban Sanitary Commission's Plumbing Code Requirements for Water-Saving Toilets." Southern Building, 34-36, Aug.-Sept. 1979.

109 - In the Washington Suburban Sanitary Commission service area, plumbing codes requiring water saving devices have been in effect since 1973. Surveys of plumbers and new homeowners have not indicated any real problems with the codes. The required watersaving fixtures have been well accepted by both installers and users. Minor problems, mostly involving the flushing action of water-saving toilets, are being resolved by the plumbing fixture industry.

Sharpe, William E. Residential and Commercial Water Conservation and Wasteflow Reduction with Water Saving Devices; Proceedings; Conference on Water Conservation and Sewage Flow Reduction with Water Saving Devices, Pennsylvania State University. U.S. Department of Commerce, NTIS PB 250 999, July 1975. p. 8-30.

110 - The current state of water-saving device technology is summarized and future research directions are recommended. Water use trends and water supply shortage areas are discussed. The legislative implications of the Federal Water Pollution Control Act Amendments of 1972 with reference to wasteflow reduction are outlined. A brief review of previous research and demonstration work with various water-saving devices is also presented. Current trends in the use and adoption of these devices are documented.

Sharpe, William E. "Water and Energy Conservation with Bathing Shower Flow Controls." American Water Works Association Journal, 93-97, Feb. 1978.

111 - Based on conflicting studies and disagreement over the effectiveness and impact of shower flow controls, a study to determine the amount of water saved was implemented in student dormitories at Pennsylvania State University. One significant point brought out is the importance of retrofitting flow controls into existing systems. Variations in plumbing design were found to have a significant impact on effectiveness. Significant reductions were observed, on the order of 37% to 62% reduction. The conclusion stated is that observed water-use reductions can, for the most part, be attributed to the changes in flow rates attributable to the flow control devices. However, mention is made of the theory that the duration of an individual shower will increase as the flow of water to the shower is decreased. Discussion of similar tests is included, as well as cost figures.

Sharpe, William. "Why Consider Water Conservation?" American Water Works Association Journal, 475-479, Sept. 1978.

112 - Water conservation can benefit both customers and utilities, but planning and pricing policies must be geared to offset potential adverse impacts on revenues. Inflationary costs seem to be

a much more serious threat to revenue stability than conservation. The proportion of rate increases necessary to offset conservation has been minor in comparison to the total rate increases sought by utilities impacted by water conservation. Customers penalized for conservation will still save money because their conservation will be subsidized by those not participating in the program, and because they will save money on energy, wastewater treatment charges, and long-term inflationary cost increases.

Shelton, Theodore B., ed. Water Conservation with Water Saving Devices. New Jersey Department of Environmental Protection through Lewis M. Herman, Labor Education Center, Cook College, Rutgers University, New Brunswick, New Jersey, November 1976.

113 - This report examines the various means of residential water conservation. The study examines use patterns, water heaters, piping, heat recovery and devices used for water conservation in showers, faucets, laundry, and dishwashers. Finally, the implications for energy savings in relation to water consumption are discussed.

Shulman, A. More Help in Developing an Education Program. National Association of Counties. p. 187-192

114 - Tips on how to develop a consumer water conservation handbook are outlined. The area covered by this article includes:

- general information to include;
- sources of information;
- how to educate children;
- other forms of media which can be employed.

Shulman, A. Public Participation: Support for Conservation Rates. National Association of Counties. p. 193-196.

115 - New rates were developed by the Washington Suburban Sanitary Commission to encourage conservation. The study concludes that the sliding rate schedule supports the overall goals of conservation at the least cost to the public. Commercial and industrial users, however, must pay much more under the new rate schedule since many of them have to pay at the higher rate. One effect of this is that businesses are now more aware of their water bills.

Sittler, Edgar L. Further Research in Water Savings; Proceedings; Conference on Water Conservation and Sewage Flow Reduction with Water Saving Devices, Pennsylvania State University. U.S. Department of Commerce, NTIS PB 250 999, July 1975. p. 175-188.

116 - This paper presents some of the present activities in water-saving devices at the Virginia Polytechnic Institute and State University Industry Center. A short discussion of the Industry Center's organization is provided. Briefly discussed are some past experiences with water-saving devices which proved both successful and unsuccessful. The major emphasis of this paper is on the areas of investigation in device technology which are expected to receive the most attention in the near future.

South Florida Water Management District. Landscaping Water Conservation, 1977. 11 p.

117 - This booklet lists 25 tips for conserving water outside the home, such as proper watering techniques and planting native vegetation. In South Florida, irrigation water use is highly variable and therefore, average per-family water use can range from 90 to 700 gallons daily.

South Florida Water Management District, Water Resource Center. Water Saving Devices, 1978. 15 p.

118 - This booklet lists water conservation devices and systems by brand name; name and address of the manufacturer or distributor; and price information when known. Devices discussed include: water meters, water pressure regulators, toilets,dual flush units, flush valves, weights, air bleeds, replacement tanks, dams, low-flow showerheads, aerators, flow restrictors, evaporation suppression, advanced water treatment and irrigation systems.

State of Illinois Department of Local Government Affairs. Plumbing Code Amendments.

119 - The Plumbing Manufacturers Institute recommends that faucet and shower discharge be lowered to a point which will reduce water consumption within limits acceptable to the consumer. They also recommend that a maximum limit be established so that the manufacturer has maximum leeway in system or component design to meet this standard. This way, the manufacturer is not burdened with a large inventory of fittings and flow rates, thus allowing more economical production and lower consumer prices.

Stone, Brian G. "Suppression of Water Use by Physical Methods." American Water Works Association Journal, 483-486, Sept. 1978.

120 - Comprehensive and detailed discussion of conservation economics. Potential savings through household water-saving devices are outlined. Based on prior studies of water use and reduction, a number of physical reduction means are suggested which include meters, pressure regulators, flow restriction, service diameter changes, hose meters and timers, moisture sensors, landscape design and residential maximum day suppression. Data is charted for various methods and savings.

Water use suppression methods, if effective, can increase conservation and reduce required system peaking capacity. Outlined are various physical methods to achieve these goals.

"Drip Irrigation." Sunset Magazine, 7, July 1975.

121 - This article describes how to use drip irrigation, how it saves water, and how much it costs. Water saving is due chiefly to the fact that evaporation with drip irrigation is reduced. Measurements of water used on certain agricultural crops show drip irrigation savings of 20% to 50% over conventional watering methods. Units can cost between $6 and $30.

"Frugality with Garden Water." Sunset Magazine, 3, June 1976.

122 - This article gives many suggestions on how to help a lawn or garden survive through a dry summer when watering is reduced. Some of these tips include: Letting your lawn go brown; using sprinkler systems; using drip irrigation; using soil saucers; soil improvement; hand-watering; and using mulches. How to determine when plants need water is outlined.

"Water Saving Planting Ideas." Sunset Magazine, 78-87, Oct. 1976

123 - Drought-tolerant plants suitable for gardens in western states are listed. Their water needs vary, depending on climate, but most can tolerate a total lack of water once they are established. About 25% of the best drought-tolerant plants are native to the arid West, mostly in California. Another 37% are from the world's other Mediterranean climates. The plants include flowering and foliage plants, vines, trees, and ground cover.

"Water-short Gardening: Here Are Some Guidelines." Sunset Magazine, 4, Apr. 1977.

124 - This article suggests how to keep plants alive through a second year of drought. Some of the suggestions are mulches, sprinkler systems, drip systems, homemade systems, subsurface irrigations, antitranspirants, and pruning. Also included is a list of northern California's indigenous plants and how much water each requires.

Tiemens, M. and P. Graham. Role of Water Conservation in the Construction Grants Program. U.S. Environmental Protection Agency, October 1978. 12 p.

125 - This paper presents potential savings of money, water and energy attainable for typical households from installation of cost-effective water-saving devices, including shower and toilet water reducers. From broad water management and resource conserva-

tion perspectives, resource savings, monetary cost reductions and other benefits are significant. The increased treatment plant efficiency attainable from water conservation will reduce mass emissions of pollutants and, as a result, enhance water quality.

U.S. Department of Housing and Urban Development, Office of Housing. Water Conservation in Housing Assistance Programs. DRAFT proposed report of task force no. 9., October 1978. 23 p.

126 - This report by HUD, the Veterans Administration, and Farmers Home Administration addresses water conservation modifications to housing assistance programs for both new and rehabilitation construction. The report concludes that water usage in Federally assisted housing might be reduced by as much as 15% within a 10-year period. Approximately 50 possible actions to achieve residential water use conservation were studied, and were broken down into actions which could be implemented immediately; actions which require further study on a short-term basis; and actions which require long-term study to justify implementation. Action possibilities considered include modification to hardware requirements for reisdential usage; development of new residential hardware that would require less water; and modifications to Federal policies to encourage conservation.

U.S. Environmental Protection Agency. National Conference on Water Conservation and Municipal Wastewater Flow Reduction, November 1978.

127 - Abstracts of the papers presented at the conference are compiled. The conference was geared to local officials. Most water conservation issues, from public support for water conservation to plumbing codes, are discussed.

U.S. Environmental Protection Agency, Office of Drinking Water. Water Supply: Wastewater Treatment Coordination Study. U.S. Environmental Protection Agency, Washington, D. C. August 1979. 352 p.

128 - This report was submitted to Congress by the U.S. Environmental Protection Agency pursuant to the Safe Drinking Water Act and the Federal Water Pollution Control Act, also known as the Clean Water Act. It documents a national assessment and analysis of issues related to: (1) the adequacy and dependability of safe drinking water supplies, including quantity, quality, cost and treatment processes; and (2) opportunities to coordinate water supply and municipal wastewater treatment plans. The study builds on recent data and results of public workshops held throughout the country to address more specifically: (1) coordination mechanisms available through major Federal programs; (2) advantages and disadvantages of conservation and reuse; (3) contamination of groundwater resources and management improvements needed; and (4) problems unique to small water supply systems. Options for modification of program emphasis, revision of existing legislation, or appropriation of funds are also discussed. Major recommendations

included: Strengthen the water quality management program; designate a lead agency for municipal water conservation; modify the construction grants program; coordinate assistance to small water supply systems; and review state and local incentives.

U.S. Environmental Protection Agency, Region I. Water Conservation in New England: It Begins At Home. June 1978. 20 p.

129 - This article lists general indoor and outdoor water conserving tips for homeowners and explains why conserving water is important even in New England where rainfall is abundant. A recent study by the U.S. Army Corps of Engineers projected that the excess daily demand on Massachusetts and Rhode Island water supplies will exceed their capacity to generate new water by 136 million gallons a day in 1980 and by over 900 million gallons a day by the year 2020. Since residential use accounts for approximately 40 percent of all water use in New England, conservation measures adopted by individual households can go a long way in solving the area's overall water shortage problems.

U.S. General Accounting Office. Municipal and Industrial Water Conservation: The Federal Government Could Do More. April 1978. 67 p.

130 - Several techniques can help make more efficient use of municipal and industrial water supplies. These include:

- domestic water-saving devices;
- metering;
- pricing;
- leakage control;
- water pressure control;
- education campaigns;
- industrial conservation.

The Federal government should take the lead in obtaining, evaluating, and disseminating information on conservation techniques, including the establishment of a clearinghouse for such information. Federal agencies should encourage water conservation techniques in the programs they administer.

University of California, Division of Agricultural Sciences. Using Household Waste Water on Plants. Leaflet #2968, April 1977.

131 - This report suggests guidelines on best ways to use gray water. It gives warnings about possible public health dangers. The safest household use of "gray water" is for toilet flushing.

Since gray water may contain bacteria and viruses that could cause illness, it's use is not recommended for irrigation of edible plants. Gray water reuse should only be used as a temporary measure during a water shortage crisis.

University of Illinois at Urbana-Champaign. "Water Conservation." Council Notes, 2,3,8, 1977.

132 - Citizens can conserve water in a number of ways, including: stopping leaks, developing water-saving habits, and installing water-saving devices. Devices described are:

- faucets: aerators, spray taps, thermostatic mixing valves, flow regulators;
- toilets: plastic bottle, volume reducers, improved float assemblies, dual flush, shallow trap toilet.

The amount of water used in various activities, both inside and outside of the home, is listed, and water-saving tips for both inside and outside of the home are presented.

Wallman, N. and G. Bonem. The Outlook for Water. Resources for the Future, Washington, D. C., 1971. 286 p.

133 - This book projects the demand and supply of our water resources and presents strategic choices to deal with the problems of water shortages. The study concludes:

1. Rapid growth projections for the year 2020 suggest that high-quality water resources on a wide scale will only be possible if we can find new technologies.
2. Even in the more immediate future high growth combined with high water quality targets have vastly expanded capital and operating costs for facilities, primarily waste treatment facilities.
3. The Southwest will remain a hard-core area of quantitative water shortage in the upper Arkansas and perhaps several other regions sharing this fate by 2020, even with medium growth.
4. On a national scale, quality is a much more difficult and costly problem than quantity and large-scale investment in water facilities will shift from its traditional home in the irrigated West to the East.

"Water Shortage Everywhere." Washington Post Editorial, Washington, D. C., October 12, 1979.

134 - This editorial emphasizes how much water is wasted and how

serious the repercussions of water waste can be. It points out that Arizona, with only 10 inches of annual rainfall, ranks among the top 10 states in per-capita water consumption. Although the U.S. has the same amount of water available as it ever did, the water is being used faster than it can be replenished. The editorial suggests that price incentives would be a big help in getting people to conserve.

Washington Suburban Sanitary Commission. Final and Comprehensive Report on WSSC's Water Conservation/Wastewater Reduction Consumer Education and Behavioral Change Program. Washington Suburban Sanitary Commission, Washington, D. C., Nov. 1974.

135 - This is a complete overview of the Washington Suburban Sanitary Commission's program which details outlays in dollars, time, and labor; general results and conclusions; and all correspondence related to the project.

Washington Suburban Sanitary Commission. How to Decrease the Demand for Water Through Changes to the Rate Structure. Washington Suburban Sanitary Commission, Washington, D. C., June 1977. p. 243-270.

136 - This report is an overview/analysis of alternative rate structures and their potential effects on water use. Three rate structures-- increasing block pricing, summer surcharge system and excess use change, are examined as potential incentive methods of reducing consumption.

Washington Suburban Sanitary Commission. It's Up to You: A Customer Handbook on Water-saving and Wastewater Reduction, May 1976. 21 p.

137 - This "How To" handbook on saving water includes detailed water conservation tips and discusses several water-saving appliances. Household hints include how to save when hand-dishwashing, using automatic dishwashers, cooking, using garbage grinders, hand and machine clothes washing, bathing and engaged in personal hygiene activities. It details how to save water with the toilet, and how to maintain clear drains. Devices described include showerheads and toilet devices. Also included is a chart on how to water local trees, shrubs, gardens and grasses.

Washington Suburban Sanitary Commission. Water Demand Reduction Facts. August 1978.

138 - This one-page fact sheet lists tips for conservation inside and outside the home and includes a chart which shows average levels of water consumption. The tips include ways to save water with the toilet; when bathing, cooking, cleaning; and outdoors.

Washington Suburban Sanitary Commission. Water Demand Reduction Plan. November 1977. 10 p.

139 - This discussion details plans for conservation and rationing. The program can be implemented in stages according to the criticality of the problem. The stages go from a shortage alert stage, where the goal is 5-10% reduction in water use, to an intense emergency situation, where 60% reduction is the goal. Steps to take under each scenario are listed.

Washington Suburban Sanitary Commission. Water Saving and Waste Reduction Handbook for Apartment Residents. September 1976. 14 p.

140 - This booklet explains reasons to save water and gives many household hints on ways to conserve water in apartments. Some of the topics discussed are the care and maintenance of the toilet, saving water in the laundry room, car-washing care, monitoring how the lawn is watered, and disposing of items through the toilet. The booklet also stresses that leaks should be reported immediately to the building management. It states that the management will do something about it because good maintenance is important to economical operation of the property.

"Water-Saving Tips", (Front Page: Carter Orders Water Resources Council To Do Project Review). Water Information News Service, 3(19):5-8, Jan. 1979.

141 - This newsletter lists many general water conservation tips for the homeowner to consider. The tips are applicable both inside and outside the home, and include ways to save water when cooking, bathing, flushing the toilet, cleaning, and gardening.

Water Resources Department. "Automatic Clothes Washers." Water Conservation Bulletin, Water Resources Department, Salem, Oregon. 137 p.

142 - Automatic clothes washers use 25-50 gallons per load. Washers with variable level controls allow the user to match the amount of water used to the amount of clothes being washed. This bulletin lists the makes, model numbers, capacities and amounts of water used by many automatic clothes washers.

Water Resources Department. "Automatic Dishwashers." Water Conservation Bulletin, Water Resources Department, Salem, Oregon. 139 p.

143 - For about the same cost, water-conserving dishwashers can save about 50% of the water used by conventional dishwashers. This bulletin includes a list of water-saving dishwashers on the market, their capacities and the amount of water used by each.

Water Resources Department. "Conserve Water and Energy Inside and Outside Your Home." Water Conservation Bulletin. Water Resources Department, Salem, Oregon.

144 - This booklet gives many tips on various ways to save water. It includes a chart showing the cost of different devices and how much water they save. The devices on the chart appropriate for new construction are:

- low-flush toilets;
- low-flow showerheads;
- low-flow kitchen and lavatory faucets;
- pressure-reducing valves;
- insulated hot water lines;
- low-flow clothes washers;
- low-flow dishwasher.

Devices on the chart for existing housing are:

- water closet inserts;
- low-flow showerheads;
- low-flow aerators on faucets;
- pressure-reducing valves;
- insulated hot water pipes.

Water Resources Department. "Faucet Controls." Water Conservation Bulletin, Water Resources Department, Salem, Oregon. 145 p.

145 - Water normally runs through a faucet at a rate of 3-12 gallons a minute. Low-flow faucets and faucet valves can restrict the flow to less than 2 gallons a minute. Such faucets usually cost $10, as compared to about $5 for a conventional faucet Faucet aerators mix air with water and cost about $2. This bulletin discusses the cost and water savings of a variety of water-conserving faucet options and lists such faucets that are on the market.

Water Resource Department. "Insulating Water Pipes." Water Conservation Bulletin, Water Resources Department, Salem, Oregon. 147 p.

146 - Pipe insulation saves unnecessary running of water and

costs about 50¢/foot. Insulation of water pipes is best done when building a home; it is more difficult and expensive to add insulation in an existing home. This bulletin lists pipe insulation products available on the market.

Water Resources Department. "Low-Volume Shower Heads and Adapters." Water Conservation Bulletin, Water Resources Department, Salem, Oregon. 135 p.

147 - Showers and baths account for about 30% of the water used inside a home. Showers typically use up to 10 gallons of water a minute which a flow adapter can cut to 3 gallons or less--a 70% savings. Prices for these devices range from about 50¢ for a simple flow adapter to somewhere between $5 and $25 for a low-volume showerhead. This bulletin lists low-volume showerheads and adapters available on the market.

Water Resources Department. "Repairing Water Leaks." Water Conservation Bulletin, Water Resources Department, Salem, Oregon. p. 75-77.

148 - This booklet describes ways to locate and repair leaky faucets and toilets. Most often, faucet leaks are caused by worn washers, which are usually easy to replace. If the drip is still there after the washer is replaced, something else may be wrong and it may be necessary to call a plumber.

Tank ball leaks can be detected with food coloring. If the dye shows up in the bowl, the ball needs replacing or is out of alignment. It may again be necessary to call a plumber.

Leaks can be detected by turning off all water for about 15 minutes and making sure the water meter remains unchanged.

Water Resources Department. "Toilet Damming Devices." Water Conservation Bulletin, Water Resources Department, Salem, Oregon. 141 p.

149 - Toilet damming devices range from plastic bottles filled with water to various commercially-made products which usually cost from $2-$4. Dams can save up to 2 gallons per flush or 5-10% of the water used inside a home. This bulletin lists water damming devices available on the market.

Water Resources Department. "Toilet Flush Adapters." Water Conservation Bulletin, Water Resources Department, Salem, Oregon. 143 p.

150 - Toilet flush adapters save water in the flushing cycle by allowing the user to vary the amount of water used to flush the toilet completely. Most are not automatic; the user must hold the flush lever down and decide when enough water has entered the bowl. Flush adapters cost from $5 to $15 and can save up to 50% of water used in toilets. This bulletin lists the flush adapters that are available on the market.

Waterbury Pressed Metal Division. Energy and Water Saving Products. Waterbury, Connecticut.

151 - This folder discusses water-conserving products which restrict water flow from a faucet or showerhead while providing a constant rate of flow at varying waterline pressures. The aerator described reduces the flow rate from a typical 6 gallons a minute to a rated maximum flow of 2-3/4 gallons per minutes. The folder also includes a diagram of typical hot and cold household water usage.

Waterbury Pressed Metal Division. Waterbury Water Conservation Attachments. Waterbury, Connecticut, January 1978.

152 - This article lists water and energy costs for an average family of 4 in each of the 50 states; and annual water and energy cost savings using water-conserving devices in each state.

Watts Regulator Company. 23 Questions and Answers About Water Pressure Reducing Valves. Lawrence, Massachusetts.

153 - This question and answer booklet on pressure regulators points out that they are not only water pressure controls, but are actually "primary conservation controls" which automatically conserve water and energy when used in high pressure areas. Approximate cost for a regulator and its installation would be $50.

Wentz, Robert J. A Plumbingware Manufacturer's Viewpoint on Water Saving Devices; Proceedings; Conference on Water Conservation and Sewage Flow Reduction with Water Saving Devices, Pennsylvania State University. U.S. Department of Commerce, NTIS PB 250 999, July 1975. 189-208 p.

154 - The future of water-saving fixtures and fittings is more encouraging today than five or ten years ago because of the recent establishment of Federal specifications. In the past, Federal and municipal codes have been very general. Manufacturers used these general codes as guidelines in designing their products. Although some water-saving devices have been used in the past, they were confined primarily to public installations. Some makeshift methods for reducing water usage have also been used; however, these are not recommended. Today, there are many different types of these devices being marketed. These include water-saving water closets; flow control devices in supply fittings for lavatories, sinks, and tub/showers; and water-saving urinals. The future of such devices may include further modification of the proverbial "Dear John" water closet, or more radical changes such as a vacuum system, flush valves in homes, or chemical systems. Effective water conservation in a community can be achieved by adopting a three phase program. No amount of research and development on water saving devices will be of any significance unless consumers are first made aware of the importance of water conservation.

Youngman, W. Keeping the Garden Green. Washington Suburban Sanitary Commission, 1978. 42 p.

155 - This booklet, written by a botanist, gives detailed gardening tips which save water. A watering chart for different types of vegetation is included. The importance of mulches and compost is explained, as well as ways to improve the soil so it holds water more effectively. Different types of vegetation---annuals, perennials, shrubs, trees, vegetables, and others--are explained, and methods to plant and care for them using less water are detailed. This booklet is excellent for anyone interested in maintaining a garden, whether in drought conditions or not.

PART TWO

SUMMARIES OF DATA IN BIBLIOGRAPHY

Conservation Projects 45
Cost Savings 51
Energy Requirements 56
Energy/Water Savings 62
Sewerless Wastewater Disposal Devices 79
Regional Issues 83
Residential Water Use 85
Water Rates 97
Water Saving Tips 98

CONSERVATION PROJECTS

	Reference Number 54	12
Region/Area	Elmhurst, IL	Montgonery County, MD
Plumbing Code Changes	● Water closets tank type 3.5 gallons per flush ● Water closets flush-o-meter 4 gallons maximum flow per minute ● Urinal tank type 3 gallons per flush ● Urinal flush-o-meter 3 gallons per flush ● Shower heads 3 gallons per flush ● Lavatory sink faucets 4 gallons per minute maximum flow with both hot and cold water supply fully open	
Reduction Achieved	water consumption - 15% sewage flow - 10%	
PI/PE Program	newsletter, radio, newspapers	handbook; water-saving workshops for property managers; slide-speaker program; TV & radio psa's, publicity program; community relations aids
Utility Rate Changes	to uniform unit charge & excess facilities water rate	
Use Restrictions	outdoors	
Conservation Devices	free distribution of dams	free distribution of shower flow controls, pressure-reducing valves, toilet insert devices; dye tabs
Cost of Program	$1.00/person in service area	

CONSERVATION PROJECTS

	Reference Number	
	29	78
Region/Area	State of CA	
Plumbing Code Changes		
Reduction Achieved		
PI/PE Program	Drought Info. Center; educational material to public, media, schools, water mgmt. agencies; psa's; buttons, bumper stickers, decals; brochures; conferences & conventions;	newsletter; bill inserts; news releases; psa's; community group involvement
Utility Rate Changes		
Use Restrictions		
Conservation Devices		
Cost of Program		

CONSERVATION PROJECTS

	Reference Number			
	63	63	63	
Region/Area	N.Y. City	Pinellas County, FL	Marin County, CA	
Plumbing Code Changes				
Reduction Achieved	12%	30%	27%	
PI/PE Program				
Utility Rate Changes				
Use Restrictions				
Conservation Devices				
Cost of Program				

CONSERVATION PROJECTS

Reference Number 78

Printed Materials	Design	Printing	Quantity
Newsletter	$ 100-500	$ 25-300	1000
Bill Inserts	200-700	6-25	1000
Slogan Stickers	300-700	16-20	1000
Lapel Buttons	50-400	70-100	1000
Truck Decals	50-200	1- 1.30	each
Key Chains	100-400	130-200	1000
Litter Bags	50-400	50- 55	1000
Matchbooks	0-100	13- 16	1000
Posters	300-700	80-100	1000
Bus Posters	300-700	20-100	1000

Broadcast Materials	Production	Per Print
Television Public Service Announcement/30 seconds	$ 400-15,000	$ 8- 12
Radio Public Service Announcement/30 seconds	50- 200	1.50
Motion Picture/10 minutes	5000-25,000	50-100

CONSERVATION PROJECTS

Reference Number 63

ACTIVITY	Alameda Co. FC&WCD	Alameda Co. Water Dist.	Calif. Water Serv. Co.	City of Antioch	City of Daly City	City of Fairfield	City of Milpitas	City of Mountain View	City of Napa	City of Palo Alto	City of Petaluma	City of Pittsburg	City of San Fran	City of Santa Clara	City of Santa Rosa	City of Vacaville	City of Vallejo	Contra Costa Co. WD	East Bay MUD	Great Oaks Water Co.	Marin Mun. Water District	North Marin Co. WD	San Jose Water Works	Santa Clara Valley WD	Sonoma Co. Water Dist.
Meter all services	-	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	-
Eliminated declining block rates	-					x						x									x	x		-	-
Phasing out declining block rates	-		x				x		x	x						x		x						-	-
Have seasonal or peak demand rates	-																							-	-
Active leak detection program	-				x			x			x		x	x	x	x	x	x	x	x	x	x	x	-	-
Assist consumer in leak detection	-	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	-	-
Pressure regulators required	-	x	x	-				-	x	x		x		-	x	x	x	x	x		x	x		-	-
Develop or purchase w. c. info:																									
Bill stuffers		x	x		x						x							x	x		x	x			
Direct mail																		x							
Paid newspaper ads					x						x										x			x	
Paid radio spots																			x		x			x	
Paid TV spots																		x	x		x			x	
Paid periodical ads																							x		
Demonstration booths																	x		x		x		x	x	
Community forums	x	x		x							x						x	x	x		x	x		x	
Speakers bureau	x	x							x		x				x		x	x	x		x	x		x	x
Materials developed for schools	x	x										x					x	x	x		x			x	
Retrofit devices:																									
Delivered free																					x	x			
Free at central location																					x	x			
Certain devices available at cost																					x				
New Construction--inside use:																									
Encourage use																			x		x	x		x	
Require use of certain devices																					x	x			
New Construction--outside use:																									
Encourage use																			x		x	x		x	
Require use of certain devices																					x	x			
Drought-tolerant landscaping																									
Encourage use	x			x								x						x	x		x	x		x	x
Demonstration garden																		x			x				
Sought w. c. legislation		x													x						x	x		x	
Sought building code changes																					x	x		x	

x, affirmative response
-, not applicable
w.c., water conservation

COST SAVINGS

	Reference Number			
	57	57	57	57
Water Saved	100 gpd	24 gpd	2 gpd	30 gpd
Water Bill Savings		$3.70/year	$ .31/year	
Sewer Bill Savings		$3.90/year	$1.82/year	
Energy Bill Savings		$21.90/year	$ .32/year	
Total Cost Savings	$ 31/year	$29.50/year	$2.45/year	$9.40/year
Cost of System	$325	$14.50 c install.	$3.00/2 aerators	
Number of Persons	4	4	4	4
SYSTEM				
Inserts				
Vacuum Toilets				
Wastewater Recycling Toilet	X			
Showerhead Flow Control		X		
Faucet Aerators			X	
Shallow Trap Toilet				X
Water Recycling System				
Pressurized Tank Toilet				
Dams				

COST SAVINGS

	Reference Number		
	57	57	57
Water Saved	10 gpd	10^6 g/month	5.9×10^6 g/year
Water Bill Savings			
Sewer Bill Savings			
Energy Bill Savings			
Total Cost Savings	$3.00/year	$400/year	$275/house/year
Cost of System	0	$3.68 @	
Number of Persons	4	600 room hotel	200 homes
SYSTEM			
Inserts	X	X	
Vacuum Toilets			X
Wastewater Recycling Toilet			
Showerhead Flow Control			
Faucet Aerators			
Shallow Trap Toilet			
Water Recycling System			
Pressurized Tank Toilet			
Dams			

COST SAVINGS

	57	57
Water Saved	6 x 10^6g/year	79,000g/month
Water Bill Savings		
Sewer Bill Savings		
Energy Bill Savings		
Total Cost Savings	$5460/year	$44/month-35%
Cost of System		
Number of Persons	300 unit apt. bldg.	18 unit apt. bldg.
SYSTEM		
Inserts		
Vacuum Toilets		
Wastewater Recycling Toilet		
Showerhead Flow Control		
Faucet Aerators		
Shallow Trap Toilet	X	
Water Recycling System		
Pressurized Tank Toilet		X
Dams		

COST SAVINGS

	Reference Number		
	57	82	86
Water Saved	20%	70 gpd	10^6 g/month
Water Bill Savings		$10.24/year	
Sewer Bill Savings		$10.56/year	
Energy Bill Savings			
Total Cost Savings		$20.80/year	$400/month
Cost of System	$1300	$500	
Number of Persons	331 unit apt. bldg.	3	
SYSTEM			
Inserts			X
Vacuum Toilets			
Wastewater Recycling Toilet			
Showerhead Flow Control			
Faucet Aerators			
Shallow Trap Toilet			
Water Recycling System		X	
Pressurized Tank Toilet			
Dams	X		

COST SAVINGS

	Reference Number	
	98	98
Water Saved	100gpd	30 gpd
Water Bill Savings	$16.10/year	$4.60/year
Sewer Bill Savings	$15.30/year	$4.80/year
Energy Bill Savings		
Total Cost Savings	$13.40/year	$9.40/year
Cost of System	$325	$100
Number of Persons	4	4
SYSTEM		
Inserts		
Vacuum Toilets		
Wastewater Recycling Toilet		
Showerhead Flow Control		
Faucet Aerators		
Shallow Trap Toilet		
Water Recycling System	X for flushing	X
Pressurized Tank Toilet		
Dams		

Reference Number 96

Energy Requirements for Water Heating

Delivery Temperature °C	Water Heating Energy Requirements Per liter Wh
12.8[A]	0.0
21.1	22.0
37.8	65.9
40.6	73.3
54.4	110
60.0	125
62.8[B]	132

A - Corresponds to outdoor water use

B - Average water heater thermostat setting on new models

	Wh/liter
Water Supply	1.5
Wastewater Treatment	3.6
Water Heating[A]	0-130

A - Dependent on water delivery temperature

Type Wash	Water Temperature - °C	Percent of Wash Loads
Hot	60.0	30
Warm	37.8	50
Cold	12.8	20

Continued...

Current Water Usage and Corresponding Energy Consumption

Function	Volume (20) liters/day	Delivery Temperature °C	Energy Requirements Per household[A] Supply	Heating	WW Treatment	Total
				kWh/day		
Toilet	379	21.1[B]	0.57	4.17	1.36	6.10
Bathing	303	40.6	0.45	22.21	1.09	23.75
Clothes Washing	132	40.6	0.20	9.68	0.48	10.36
Dishwashing	57	60.0	0.09	7.13	0.21	7.43
Cooking Drinking	45	21.1[B]	0.07	0.50	0.16	0.73
Lavatory	30	40.6	0.05	2.20	0.11	2.36
Utility Sink	19	40.6	0.03	1.39	0.07	1.49
Total	965		1.46	47.28	3.48	52.22

A - based on estimates obtained in Section 3

B - Assumed to leave house at 21.1°C but pose a heating load for only six months per year

ENERGY REQUIREMENTS

Reference Number 95

Residential Water Usage and Corresponding Energy Consumption With Conventional Water Savings Devices

Function	Daily Water Usage	Approximate Delivery Temperature	Energy Requirements Per Household Water Supply	Water Heating	Wastewater Treatment	Total
	(liters)	(^{o}C)	(kwh/day)			
Toilet	242	21.1	0.36	2.66	0.87	3.89
Bathing	190	40.6	0.29	13.9	0.68	14.9
Clothes Washing	91	40.6	0.14	6.67	0.33	7.14
Dishwashing	41	60.0	0.06	5.13	0.15	5.34
Kitchen Sink	45	21.1	0.07	0.50	0.15	0.73
Lavatory	15	40.6	0.02	1.10	0.05	1.17
Utility Sink	10	40.6	0.02	0.73	0.04	0.79
Total	634		0.96	30.7	2.28	34.0

ENERGY REQUIREMENTS

Reference Number 26

FAMILY OF FOUR DAILY WATER USE CHARACTERISTICS

Toilet	5 gal/use	100	Amb.	
Bathing	4 gal/min	80	107°	55.998
Laundry	50 gal/load	35	120°	30,624
Dishwasher	15 gal/load	15	140°	17,163
Kitchen Sink		12	105°	8,076
Lavatory		8	105°	5,384
Utility		5	Amb.	-
			Fixed Loss	79,214
Total		255 gal.		196,460 Btu

+Based on Ambient water temperature of 55°F (7)

Fixed loss is the amount of energy lost from a full sized water heater regardless of water use.

Reference Number 58

Domestic Hot Water Annual Fuel Savings with Use of Water Conservation Faucets and Showerheads

Number of Apartments	#[illegible]	#6 Oil	Gas
100	$ 1,180	$ 1,298	$ 1,050
200	2,360	2,596	2,100
500	5,900	6,490	5,250
1,000	11,800	12,980	10,500

#2 oil = 20c/gal. #6 oil (.3%) = 22c/gal. Gas = .14/therm.

ENERGY REQUIREMENTS

Reference Number 88

$$2 \text{ showers/day} \times \frac{10 \text{ gallons saved}}{\text{shower}} \times \frac{8.33 \text{ lbs.}}{\text{gallon}}$$

$1.0 \times (105^{\circ} - 60^{\circ}) = 7.5 \times 10^{3}$ BTU saved/day, or 365 days/year x 7.5×10^{3} BTU/day = 2.74×10^{6} BTU/year.

For a water heater fired by gas or oil with an efficiency of 50%, the fuel saving is:

$\frac{2.74 \times 10^{6} \text{ BTU/year}}{.50} = 5.48 \times 10^{6}$ BTU/year or 39.5 gallons of oil/year.

For the nation as a whole this means a fuel savings of:

$.85 \times 44 \times 10^{6}$ homes x 5.48×10^{6} BTU/year/home = 205×10^{12} BTU/year, or 96,000 BPD

For an electric water heater, the electricity saved per home is:

$2.74 \times 10^{6} \text{ BTU/year} \times \frac{1 \text{ KWH}}{3413 \text{ BTU}} = .80 \times 10^{3}$

KWH/home/year.

For the 16 million homes with electric hot water heaters the savings is:

$.80 \times 10^{3}$ KWH/home x $.95 \times 16 \times 10^{6}$ electric homes = 12.2×10^{9} KWH/year.

To serve a load of this magnitude the nation's power stations will consume energy equal to:

$12.2 \times 10^{9} \text{ KWH} \times \frac{11{,}600 \text{ BTU}}{1 \text{ KWH}} = 142 \times 10^{12}$

BTU/year = 67,000 BPD.

The total theoretical potential saving in fuel of all kinds is: 96,000 + 67,000 = 163,000 BPD including oil, gas, coal, hydro, nuclear. About 33 percent of the electricity distributed by the nation's utilities is derived from oil and gas, thus, the oil and gas saved in power stations is approximately 1/3 x 67,000 = 22,000 BPD.

The total theoretical potential fuel savings in the form of oil and gas only is: 96,000 BPD + 22,000 BPD = 118,000 BPDOE as oil and gas.

Continued...

ENERGY REQUIREMENTS

Reference Number 88, Continued

Effect on Homeowner's Energy Expenditure

A 20 GPD reduction in the amount of warm water used in showers will result in a noticeable drop in energy bills for the individual family.

	Hot Water Heater		
	Gas fired	Oil fired	Electric
Annual energy savings per home	55 therms	40 gallons	800 KWH
Annual savings in energy bill per home			
gas at $1.50/therm	$8.25		
heating oil at 40 cents/gallon		$16.00	
electricity at 3.0 cents/KWH			$24.00

ENERGY/WATER SAVINGS

	Reference Number	
	7 Household Use	84
Shallow Trap Toilet	7.5 gpcd-12%	
Pressurized Tank Toilet		
Vacuum Toilet	22.5 gpcd	22.5 gpcd-35%
Incinerator Toilet		
Pressurized Flush Toilet		
Wastewater Recycling Toilet		
Oil Flush Toilet		25 gpcd-39%
Freeze Toilet		
Packaging Toilet		
Composter Toilet		
Dual Flush Toilet	17.5 gpcd	15.5gpcd-24%
Water Closet Insert	2.5 gpcd-4%	
Water Dams	5 gpcd-8%	
Microphore Toilet		
Toilet Flush Adapters		
Flush Valve Toilet	7.5 gpcd-12%	7.5gpcd-12%
Shower Mixing Valves		
Shower Flow-Control Devices	6 gpcd	6 gpcd-9%
Air-Assisted Showerhead		
Pressure-Reducing Valves		16gpcd-20%
Pressure-Reducing Valves & Toilet Inserts		
Premixed Water System		
Faucet Aerators	.5gpcd-.8%	.5gpcd-1%
Faucet Flow Restrictors	.5gpcd-.8%	.5gpcd-1%
Spray Tap		
Pressure Balancing Mixing Valve		
Repair Leaking Faucets		
Hot Water (1 g.)		
Water Recycling System		for flushing 25 gpcd-39%
Front Loading vs. Top Loading Clotheswashers		
Hot Water Pipe Insulation	2 gpcd-3%	
Moisture Sensors		
Landscape Design		
Drip Irrigation		
Swimming Pool Cover		
Low Water-Using Dishwasher		
Low Flush Toilet		
Thermostatic Mixing Valve		
Compressed Air Toilet		
Minuse Shower		
Low Flow Showerhead		
Flow Limit Valves		
Low Water-Using Clotheswasher		
Pressure Regulation		

ENERGY/WATER SAVINGS

	63	115
Shallow Trap Toilet		
Pressurized Tank Toilet		
Vacuum Toilet		
Incinerator Toilet		
Pressurized Flush Toilet		
Wastewater Recycling Toilet		
Oil Flush Toilet		
Freeze Toilet		
Packaging Toilet		
Composter Toilet		
Dual Flush Toilet		
Water Closet Insert		
Water Dams		total use .5g/flush
Microphore Toilet		
Toilet Flush Adapters		
Flush Valve Toilet		
Shower Mixing Valves		
Shower Flow-Control Devices	6.8gpcd-5.4%	
Air-Assisted Showerhead		
Pressure-Reducing Valves		
Pressure-Reducing Valves & Toilet Inserts		
Premixed Water System		
Faucet Aerators	.8gpcd-.6%	
Faucet Flow Restrictors		
Spray Tap		
Pressure Balancing Mixing Valve		
Repair Leaking Faucets		
Hot Water (1 g.)		
Water Recycling System		
Front Loading vs. Top Loading Clotheswashers		
Hot Water Pipe Insulation	1gpcd-.8%	
Moisture Sensors		
Landscape Design		
Drip Irrigation		
Swimming Pool Cover		
Low Water-Using Dishwasher		
Low Flush Toilet		
Thermostatic Mixing Valve		
Compressed Air Toilet		
Minuse Shower		
Low Flow Showerhead		
Flow Limit Valves		
Low Water-Using Clotheswasher		
Pressure Regulation		

ENERGY/WATER SAVINGS

	Reference Number	
	45	57
Shallow Trap Toilet		15% total water
Pressurized Tank Toilet		33% flushing water
Vacuum Toilet		50%-60%
Incinerator Toilet		94%
Pressurized Flush Toilet		
Wastewater Recycling Toilet		90%
Oil Flush Toilet		
Freeze Toilet		100%
Packaging Toilet		
Composter Toilet		100%
Dual Flush Toilet		
Water Closet Insert		
Water Dams		33 1/3%
Microphore Toilet		
Toilet Flush Adapters		
Flush Valve Toilet		
Shower Mixing Valves		
Shower Flow-Control Devices		18%-20%
Air-Assisted Showerhead		83%-95%water,29%-48%energy
Pressure-Reducing Valves		30%
Pressure-Reducing Valves & Toilet Inserts		
Premixed Water System	33% use hot water	
Faucet Aerators		
Faucet Flow Restrictors		70%
Spray Tap		
Pressure Balancing Mixing Valve		12%
Repair Leaking Faucets		
Hot Water (1 g.)		
Water Recycling System		
Front Loading vs. Top Loading Clotheswashers		
Hot Water Pipe Insulation		
Moisture Sensors		
Landscape Design		
Drip Irrigation		
Swimming Pool Cover		
Low Water-Using Dishwasher		
Low Flush Toilet		
Thermostatic Mixing Valve		
Compressed Air Toilet		
Minuse Shower		
Low Flow Showerhead		
Flow Limit Valves		
Low Water-Using Clotheswasher		
Pressure Regulation		

ENERGY/WATER SAVINGS

	Reference Number			
	81	84	111	113
Shallow Trap Toilet				
Pressurized Tank Toilet				
Vacuum Toilet				
Incinerator Toilet				
Pressurized Flush Toilet				
Wastewater Recycling Toilet				
Oil Flush Toilet				
Freeze Toilet				
Packaging Toilet				
Composter Toilet				
Dual Flush Toilet				
Water Closet Insert		12%-20%		
Water Dams	40%			
Microphore Toilet				
Toilet Flush Adapters	50%			
Flush Valve Toilet				
Shower Mixing Valves				
Shower Flow-Control Devices		12%	36%-45%	
Air-Assisted Showerhead				
Pressure-Reducing Valves		16%-24%		
Pressure-Reducing Valves & Toilet Inserts				
Premixed Water System				
Faucet Aerators				25%
Faucet Flow Restrictors				25%
Spray Tap				50%
Pressure Balancing Mixing Valve				
Repair Leaking Faucets				
Hot Water (1 g.)				
Water Recycling System				
Front Loading vs. Top Loading Clotheswashers				
Hot Water Pipe Insulation				
Moisture Sensors				
Landscape Design				
Drip Irrigation				
Swimming Pool Cover				
Low Water-Using Dishwasher				
Low Flush Toilet				
Thermostatic Mixing Valve				
Compressed Air Toilet				
Minuse Shower				
Low Flow Showerhead				
Flow Limit Valves				
Low Water-Using Clotheswasher				
Pressure Regulation				

ENERGY/WATER SAVINGS

	Reference Number	
	120	100
Shallow Trap Toilet		
Pressurized Tank Toilet		
Vacuum Toilet		
Incinerator Toilet		
Pressurized Flush Toilet		
Wastewater Recycling Toilet		
Oil Flush Toilet		
Freeze Toilet		
Packaging Toilet		
Composter Toilet		
Dual Flush Toilet		
Water Closet Insert		
Water Dams		
Microphore Toilet		
Toilet Flush Adapters		
Flush Valve Toilet		
Shower Mixing Valves	7.5	750-5000g/year
Shower Flow-Control Devices	0-gpcd 0-12%	
Air-Assisted Showerhead		
Pressure-Reducing Valves	0-16 gpcd 0-20%	
Pressure-Reducing Valves & Toilet Inserts		
Premixed Water System		
Faucet Aerators	1%-.5gpd	
Faucet Flow Restrictors	0-20%	
Spray Tap		
Pressure Balancing Mixing Valve	0-27%	
Repair Leaking Faucets		750-5000g/year
Hot Water (1 g.)		220 watts or 750
Water Recycling System		
Front Loading vs. Top Loading Clotheswashers		
Hot Water Pipe Insulation	1-4% 0-6gpd	
Moisture Sensors	0-20%	
Landscape Design	0-50%	
Drip Irrigation		
Swimming Pool Cover		
Low Water-Using Dishwasher		
Low Flush Toilet		
Thermostatic Mixing Valve		
Compressed Air Toilet		
Minuse Shower		
Low Flow Showerhead		
Flow Limit Valves		
Low Water-Using Clotheswasher		
Pressure Regulation		

ENERGY/WATER SAVINGS

	Reference Number			
	53	130	101	26
Shallow Trap Toilet				
Pressurized Tank Toilet				
Vacuum Toilet				
Incinerator Toilet				
Pressurized Flush Toilet				
Wastewater Recycling Toilet				
Oil Flush Toilet				
Freeze Toilet				
Packaging Toilet				
Composter Toilet				
Dual Flush Toilet				
Water Closet Insert				
Water Dams			50%	
Microphore Toilet				68%-86%
Toilet Flush Adapters				
Flush Valve Toilet				
Shower Mixing Valves				
Shower Flow-Control Devices	1.2%-2%	12%		
Air-Assisted Showerhead				
Pressure-Reducing Valves				
Pressure-Reducing Valves & Toilet Inserts	30%-37%	30%		
Premixed Water System				
Faucet Aerators				
Faucet Flow Restrictors				
Spray Tap				
Pressure Balancing Mixing Valve				
Repair Leaking Faucets				
Hot Water (1 g.)				
Water Recycling System				
Front Loading vs. Top Loading Clotheswashers				
Hot Water Pipe Insulation				
Moisture Sensors				
Landscape Design				
Drip Irrigation				
Swimming Pool Cover				
Low Water-Using Dishwasher				
Low Flush Toilet				
Thermostatic Mixing Valve				
Compressed Air Toilet				
Minuse Shower				
Low Flow Showerhead				
Flow Limit Valves				
Low Water-Using Clotheswasher				
Pressure Regulation				

ENERGY/WATER SAVINGS

	Reference Number	
	9	95
Shallow Trap Toilet		
Pressurized Tank Toilet		
Vacuum Toilet		
Incinerator Toilet		
Pressurized Flush Toilet		
Wastewater Recycling Toilet		
Oil Flush Toilet		
Freeze Toilet		
Packaging Toilet		
Composter Toilet		
Dual Flush Toilet		
Water Closet Insert		
Water Dams		
Microphore Toilet		
Toilet Flush Adapters		
Flush Valve Toilet		
Shower Mixing Valves		
Shower Flow-Control Devices		
Air-Assisted Showerhead		
Pressure-Reducing Valves		
Pressure-Reducing Valves & Toilet Inserts		
Premixed Water System		
Faucet Aerators		
Faucet Flow Restrictors		
Spray Tap		
Pressure Balancing Mixing Valve		
Repair Leaking Faucets		
Hot Water (1 g.)		
Water Recycling System		39% toilet flushing
Front Loading vs. Top Loading Clotheswashers	60%-65%	
Hot Water Pipe Insulation		
Moisture Sensors		
Landscape Design		
Drip Irrigation		
Swimming Pool Cover		
Low Water-Using Dishwasher		
Low Flush Toilet		
Thermostatic Mixing Valve		
Compressed Air Toilet		
Minuse Shower		
Low Flow Showerhead		
Flow Limit Valves		
Low Water-Using Clotheswasher		
Pressure Regulation		

ENERGY/WATER SAVINGS

	Reference Number		
	93	32	122
Shallow Trap Toilet	30%-33%		
Pressurized Tank Toilet			
Vacuum Toilet			
Incinerator Toilet			
Pressurized Flush Toilet			
Wastewater Recycling Toilet			
Oil Flush Toilet			
Freeze Toilet			
Packaging Toilet			
Composter Toilet			
Dual Flush Toilet			
Water Closet Insert		10%-18%	
Water Dams			
Microphore Toilet			
Toilet Flush Adapters			
Flush Valve Toilet	3-4g/flush		
Shower Mixing Valves			
Shower Flow-Control Devices		9%-12%	
Air-Assisted Showerhead			
Pressure-Reducing Valves			
Pressure-Reducing Valves & Toilet Inserts			
Premixed Water System			
Faucet Aerators			
Faucet Flow Restrictors			
Spray Tap			
Pressure Balancing Mixing Valve			
Repair Leaking Faucets			
Hot Water (1 g.)			
Water Recycling System			
Front Loading vs. Top Loading Clotheswashers			
Hot Water Pipe Insulation	2 gpcd		
Moisture Sensors			
Landscape Design			
Drip Irrigation			20%-50%
Swimming Pool Cover			
Low Water-Using Dishwasher			
Low Flush Toilet			
Thermostatic Mixing Valve			
Compressed Air Toilet			
Minuse Shower			
Low Flow Showerhead			
Flow Limit Valves			
Low Water-Using Clotheswasher			
Pressure Regulation			

ENERGY/WATER SAVINGS

	Reference Number		
			% of Interior Use
	118	36	76
Shallow Trap Toilet		33%	18%
Pressurized Tank Toilet		55%	
Vacuum Toilet		94%	
Incinerator Toilet		100%	
Pressurized Flush Toilet		100%	
Wastewater Recycling Toilet		100%	
Oil Flush Toilet		100%	
Freeze Toilet		100%	
Packaging Toilet		100%	
Composter Toilet		100%	
Dual Flush Toilet		20%	
Water Closet Insert		5%-30%	18%
Water Dams			
Microphore Toilet			
Toilet Flush Adapters			
Flush Valve Toilet			
Shower Mixing Valves			
Shower Flow-Control Devices			12%
Air-Assisted Showerhead		1%-15%	
Pressure-Reducing Valves			5%
Pressure-Reducing Valves & Toilet Inserts			
Premixed Water System			
Faucet Aerators			
Faucet Flow Restrictors			2%
Spray Tap			
Pressure Balancing Mixing Valve			
Repair Leaking Faucets			
Hot Water (1 g.)			
Water Recycling System			
Front Loading vs. Top Loading Clotheswashers			5%
Hot Water Pipe Insulation			4%
Moisture Sensors			
Landscape Design			
Drip Irrigation			
Swimming Pool Cover	100gpcd-20x40ft		
Low Water-Using Dishwasher			
Low Flush Toilet			
Thermostatic Mixing Valve			
Compressed Air Toilet			
Minuse Shower			
Low Flow Showerhead			
Flow Limit Valves			
Low Water-Using Clotheswasher			
Pressure Regulation			

ENERGY/WATER SAVINGS

	Reference Number	
	92	113
Shallow Trap Toilet		
Pressurized Tank Toilet		
Vacuum Toilet		
Incinerator Toilet		
Pressurized Flush Toilet		
Wastewater Recycling Toilet		
Oil Flush Toilet		
Freeze Toilet		
Packaging Toilet		
Composter Toilet		
Dual Flush Toilet		
Water Closet Insert		
Water Dams		
Microphore Toilet		
Toilet Flush Adapters		
Flush Valve Toilet		
Shower Mixing Valves		50-70%=5.5g/person/day,2000/p/yr
Shower Flow-Control Devices	6.8gpcd-5.4%	
Air-Assisted Showerhead		
Pressure-Reducing Valves		
Pressure-Reducing Valves & Toilet Inserts		
Premixed Water System		
Faucet Aerators	.8gpcd-.6%	
Faucet Flow Restrictors		
Spray Tap		
Pressure Balancing Mixing Valve		
Repair Leaking Faucets		
Hot Water (1 g.)		
Water Recycling System		
Front Loading vs. Top Loading Clotheswashers		
Hot Water Pipe Insulation	1gpcd-.8%	
Moisture Sensors		
Landscape Design		
Drip Irrigation		
Swimming Pool Cover		
Low Water-Using Dishwasher		
Low Flush Toilet		
Thermostatic Mixing Valve		
Compressed Air Toilet		
Minuse Shower		
Low Flow Showerhead		
Flow Limit Valves		
Low Water-Using Clotheswasher		
Pressure Regulation		

ENERGY/WATER SAVINGS

	Reference Number		
	113	113	113
Shallow Trap Toilet			
Pressurized Tank Toilet			
Vacuum Toilet			
Incinerator Toilet			
Pressurized Flush Toilet			
Wastewater Recycling Toilet			
Oil Flush Toilet			
Freeze Toilet			
Packaging Toilet			
Composter Toilet			
Dual Flush Toilet			
Water Closet Insert			
Water Dams			
Microphore Toilet			
Toilet Flush Adapters			
Flush Valve Toilet			
Shower Mixing Valves	16g/shower	15g/shower	18g/shower
Shower Flow-Control Devices			
Air-Assisted Showerhead			
Pressure-Reducing Valves			
Pressure-Reducing Valves & Toilet Inserts			
Premixed Water System			
Faucet Aerators			
Faucet Flow Restrictors			
Spray Tap			
Pressure Balancing Mixing Valve			
Repair Leaking Faucets			
Hot Water (1 g.)			
Water Recycling System			
Front Loading vs. Top Loading Clotheswashers			
Hot Water Pipe Insulation			
Moisture Sensors			
Landscape Design			
Drip Irrigation			
Swimming Pool Cover			
Low Water-Using Dishwasher			
Low Flush Toilet			
Thermostatic Mixing Valve			
Compressed Air Toilet			
Minuse Shower			
Low Flow Showerhead			
Flow Limit Valves			
Low Water-Using Clotheswasher			
Pressure Regulation			

ENERGY/WATER SAVINGS

	Reference Number		
	113	113	113
Shallow Trap Toilet			
Pressurized Tank Toilet			
Vacuum Toilet			
Incinerator Toilet			
Pressurized Flush Toilet			
Wastewater Recycling Toilet			
Oil Flush Toilet			
Freeze Toilet			
Packaging Toilet			
Composter Toilet			
Dual Flush Toilet			
Water Closet Insert			
Water Dams			
Microphore Toilet			
Toilet Flush Adapters			
Flush Valve Toilet			
Shower Mixing Valves	50%	6gpcd	40gpd/home
Shower Flow-Control Devices			
Air-Assisted Showerhead			
Pressure-Reducing Valves			
Pressure-Reducing Valves & Toilet Inserts			
Premixed Water System			
Faucet Aerators			
Faucet Flow Restrictors			
Spray Tap			
Pressure Balancing Mixing Valve			
Repair Leaking Faucets			
Hot Water (1 g.)			
Water Recycling System			
Front Loading vs. Top Loading Clotheswashers			
Hot Water Pipe Insulation			
Moisture Sensors			
Landscape Design			
Drip Irrigation			
Swimming Pool Cover			
Low Water-Using Dishwasher			
Low Flush Toilet			
Thermostatic Mixing Valve			
Compressed Air Toilet			
Minuse Shower			
Low Flow Showerhead			
Flow Limit Valves			
Low Water-Using Clotheswasher			
Pressure Regulation			

ENERGY/WATER SAVINGS

	Reference Number		
	% of Interior Use		
	120	76	92
Shallow Trap Toilet			
Pressurized Tank Toilet			
Vacuum Toilet			
Incinerator Toilet			
Pressurized Flush Toilet			
Wastewater Recycling Toilet			
Oil Flush Toilet			
Freeze Toilet			
Packaging Toilet			
Composter Toilet			
Dual Flush Toilet			
Water Closet Insert			
Water Dams			
Microphore Toilet			
Toilet Flush Adapters			
Flush Valve Toilet			
Shower Mixing Valves			
Shower Flow-Control Devices			
Air-Assisted Showerhead			
Pressure-Reducing Valves			
Pressure-Reducing Valves & Toilet Inserts			
Premixed Water System			
Faucet Aerators			
Faucet Flow Restrictors			
Spray Tap			
Pressure Balancing Mixing Valve			
Repair Leaking Faucets			
Hot Water (1 g.)			
Water Recycling System			
Front Loading vs. Top Loading Clotheswashers			
Hot Water Pipe Insulation			
Moisture Sensors			
Landscape Design			
Drip Irrigation			
Swimming Pool Cover			
Low Water-Using Dishwasher	0.4%,0-6gpd	4%	9gpcd-72%
Low Flush Toilet			
Thermostatic Mixing Valve			1gpcd-1%
Compressed Air Toilet			
Minuse Shower			
Low Flow Showerhead			
Flow Limit Valves	1%-.5gpd		
Low Water-Using Clotheswasher	0-5%,0-8gpd		
Pressure Regulation	0-27%		

ENERGY/WATER SAVINGS

	Reference Number	
	7	84
Shallow Trap Toilet		
Pressurized Tank Toilet		
Vacuum Toilet		
Incinerator Toilet		
Pressurized Flush Toilet		
Wastewater Recycling Toilet		
Oil Flush Toilet		
Freeze Toilet		
Packaging Toilet		
Composter Toilet		
Dual Flush Toilet		
Water Closet Insert		
Water Dams		
Microphore Toilet		
Toilet Flush Adapters		
Flush Valve Toilet		
Shower Mixing Valves		
Shower Flow-Control Devices		
Air-Assisted Showerhead		
Pressure-Reducing Valves		
Pressure-Reducing Valves & Toilet Inserts		
Premixed Water System		
Faucet Aerators		
Faucet Flow Restrictors		
Spray Tap		
Pressure Balancing Mixing Valve		
Repair Leaking Faucets		
Hot Water (1 g.)		
Water Recycling System		
Front Loading vs. Top Loading Clotheswashers		
Hot Water Pipe Insulation		
Moisture Sensors		
Landscape Design		
Drip Irrigation		
Swimming Pool Cover		
Low Water-Using Dishwasher		
Low Flush Toilet		
Thermostatic Mixing Valve	2gpcd-3%	7.5gpcd-12%
Compressed Air Toilet	25gpcd-39%	
Minuse Shower	14gpcd-22%	
Low Flow Showerhead	7.5gpcd-12%	7.5gpcd-12%
Flow Limit Valves		
Low Water-Using Clotheswasher		
Pressure Regulation		

ENERGY/WATER SAVINGS

	Reference Number	
	63	115
Shallow Trap Toilet		
Pressurized Tank Toilet		
Vacuum Toilet		
Incinerator Toilet		
Pressurized Flush Toilet		
Wastewater Recycling Toilet		
Oil Flush Toilet		
Freeze Toilet		
Packaging Toilet		
Composter Toilet		
Dual Flush Toilet		
Water Closet Insert		
Water Dams		
Microphore Toilet		
Toilet Flush Adapters		
Flush Valve Toilet		
Shower Mixing Valves		
Shower Flow-Control Devices		
Air-Assisted Showerhead		
Pressure-Reducing Valves		
Pressure-Reducing Valves & Toilet Inserts		
Premixed Water System		
Faucet Aerators		
Faucet Flow Restrictors		
Spray Tap		
Pressure Balancing Mixing Valve		
Repair Leaking Faucets		
Hot Water (1 g.)		
Water Recycling System		
Front Loading vs. Top Loading Clotheswashers		
Hot Water Pipe Insulation		
Moisture Sensors		
Landscape Design		
Drip Irrigation		
Swimming Pool Cover		
Low Water-Using Dishwasher		
Low Flush Toilet	9gpcd-7.1%	
Thermostatic Mixing Valve	1gpcd-1%	
Compressed Air Toilet		
Minuse Shower		total use-.5g/min.
Low Flow Showerhead		
Flow Limit Valves		
Low Water-Using Clotheswasher		
Pressure Regulation		

ENERGY/WATER SAVINGS

Reference Number
115

Shallow Trap Toilet
Pressurized Tank Toilet
Vacuum Toilet
Incinerator Toilet
Pressurized Flush Toilet
Wastewater Recycling Toilet
Oil Flush Toilet
Freeze Toilet
Packaging Toilet
Composter Toilet
Dual Flush Toilet
Water Closet Insert
Water Dams
Microphore Toilet
Toilet Flush Adapters
Flush Valve Toilet
Shower Mixing Valves
Shower Flow-Control Devices
Air-Assisted Showerhead
Pressure-Reducing Valves
Pressure-Reducing Valves & Toilet Inserts
Premixed Water System
Faucet Aerators
Faucet Flow Restrictors
Spray Tap
Pressure Balancing Mixing Valve
Repair Leaking Faucets
Hot Water (1 g.)
Water Recycling System
Front Loading vs. Top Loading Clotheswashers
Hot Water Pipe Insulation
Moisture Sensors
Landscape Design
Drip Irrigation
Swimming Pool Cover
Low Water-Using Dishwasher
Low Flush Toilet
Thermostatic Mixing Valve
Compressed Air Toilet
Minuse Shower
Energy Savings 60%
Low Flow Showerhead
Flow Limit Valves
Low Water-Using Clotheswasher
Pressure Regulation

ENERGY/WATER SAVINGS

Reference Number 33

Fixture Action	Water Use		Percent Savings Total Interior		Incremental Cost		In-House
	Standard	Improved	New	Retro	New $	Retro $	Energy Savings
Tank Toilet	5-7 gallons (19 to 26 litres) per flush	3.5 gallons (13 litres) per flush	10-18	10-18	$0-$10	$0-$6	No
Shower	up to 12 gallons (45 litres) per minute	3.0 gallons (11 litres) per minute	9-12	9-12	$0-$5	$1-$5	Yes
Kitchen and Lavatory faucets	up to 5 gallons (20 litres) per minute	1.5 gallons (5.7 litres) per minute[1]	0-2[2]	0-2[2]	$0-$5	$1-$5	Yes
Pressure reducing valve	80 pounds per square inch (550 kilopascals)	50 pounds per square inch (340 kilopascals)	0-10	0-10	$0-$25	$25	Yes
Hot water pipe insulation[6]	Not insulated	Insulated	1-4[2]	0-1[2]	$0.50-$1.00 per foot	$0.50 per foot	Yes
Automatic clothes washer[7]	27-54 gallons (100-200 litres) per load	16-19 gallons (61-72 litres) per load	0-5	-	$20-$30	Not practical	Yes
Automatic dishwasher[7]	7.5-16 gallons (28-61 litres) per load	7.5 gallons (28 litres) per load	0-4[4]	-	0	Not practical	Yes
TOTAL			20-55[5]	19-43[5]			

1. Attachments marketed with 0.5 gallon (2 litre) per minute flow. Residential acceptance unknown but commercially proven.
2. No field quantification.
3. Retrofitting may not always be practical.
4. Based on one load per day.
5. Educate to only wash full loads, turn off water faucets unless actually used, etc., could add another percent or two to the totals.
6. Insulation of certain continuously circulating hot water piping is already required.
7. 59% of the households in Los Angeles area have washing machines and 24% have dishwashers.

SEWERLESS WASTEWATER DISPOSAL DEVICES

Reference Number 89

SYSTEM	Site Conditions for Which System May Be Considered Appropriate
1. Compost Toilet - Large Volume	Climate: moderate, warm (cold may be considered) Home Setting: rural, rural remote Means of Disposal: grey water only Availability of water resources: water shortage Home Layout: Lot Size: small Lot Topography: steep terrain Soil Conditions: impervious, over bedrock Demography: Population Size: 1 family Family Size: 1-10 Population Density: sparse Population Background: Population Education: high
2. Compost Toilet - Small Volume	Same conditions as in 1 except: System restricted to 3 users.
3. Oil Flush Toilet	Application for Homes: questionable System is designed for public use (highway rest areas).
4. Chemical Toilets	Application for Homes: questionable System is designed for mobile homes, and public facilities. May be used as temporary arrangement to accommodate 1-4 people.
5. Microphor Toilets	Means of Disposal: total disposal (limited) Availability of Water Resources: water shortage Soil Conditions: slowly permeable soil

Continued...

SEWERLESS WASTEWATER DISPOSAL DEVICES

Reference Number 89, Continued

SYSTEM	Site Conditions for Which System May Be Considered Appropriate
6. Incinerating Toilets - Electricity Operated	Home Setting: rural Means of Disposal: no disposal, ground water only Availability of Water Resources: water shortage Home Layout: Lot Size: small Lot Topography: steep Soil Conditions: impervious, over bedrock Demography: Population Size: 1 family Family Size: 1-3 Population Density: sparse
7. Incinerating Toilets - Gas Operated	Same as 6, and may be preferred as its incinerating efficiency is higher.
8. Pressurized Tank Toilet	May be applied anywhere with the potential of water saving of 40% of toilet use water. May serve an apartment house.
9. Packaging Toilet 10. Freezing Toilet	Information on the systems performance was not obtained. The systems serve summer homes in Sweden and Norway.
11. Vacuum Toilets	Home Setting: urban Means of Disposal: grey water only Availability of Water Resources: water shortage Home Layout: Lot Topography: steep terrain Demography: Population Size: 100-200 families Population Density: dense Population Background: Population Education: moderately high
12. Suds Operated Toilet	Means of Disposal: total disposal Availability of Water Resources: water shortage
13. Macerator Toilet	Means of Disposal: total disposal Availability of Water Resources: water shortage

Continued...

SEWERLESS WASTEWATER DISPOSAL DEVICES
Reference Number 89, Continued

SYSTEM	Site Conditions for Which System May Be Considered Appropriate
14. Recirculating Toilet	Means of Disposal: grey water only Availability of Water Resources: water shortage
15. Dual Flush Toilet	Potential Water Savings 40%
16. Wash Down European Toilet	Potential Water Savings 50%
17. Grey Water Systems for Toilet Reuse	Means of Disposal: total disposal Availability of Water Resources: water shortage
18. Total Waste water System Toilet Reuse	Means of Disposal: no disposal Availability of Water Resources: water shortage Home Layout: Lot Size: small Lot Topography: steep terrain Soil Conditions: impervious, over bedrock Demography: Population Size: 6-20 Population Density: moderately dense to NOTE: Population requirement is important to assure the availability of maintenance personnel and possible, to construct a community collective system. Population Income: high
19. Total Wastewater System for Total Reuse	Same site conditions as for 18. May be required for very severe water shortage areas.
20. Septic Tank - Mound System	Home Setting: rural remote to suburban Means of Wastewater Disposal Degree of Disposal: total disposal Point of Discharge: ground Availability of Water Resources: adequate Home Layout: Lot Size: moderate Lot Topography: level to moderately slopy Soil Conditions: slowly permeable shallow permeable permeable with high water table

Continued...

SEWERLESS WASTEWATER DISPOSAL DEVICES

Reference Number 89, Continued

SYSTEM	Site Conditions for Which System May Be Considered Appropriate
21. Aerobic Tank - Mound	Same as system 20. Aerobic system may be more efficient in delivering effluent to the mound of higher quality. Comparison between system 20 and 21 needs further study.
22. Aerobic Tank - E-T Bed	Geography-Climate: low to moderate precipitation Degree of Disposal: no disposal Availability of Water Resources: moderate Home Layout: Lot Size: medium, large Lot Topography: level ground Soil Conditions: impervious or when no percolation is mandatory Demography: Population Density: sparse to moderately dense
23. Spray Irrigation	Same conditions as in 22.
24. Grey Water Disposal System by Sand Filtration and Disinfection	Used in conjunction with composting toilet

REGIONAL ISSUES

Reference Number

	Max. regulated flow	Medium			High
		1980	2000	2020	2020
		(billion gallons per day)			
New England	60,895	3,177	4,522	6,474	9,935
Delaware and Hudson	28,629	6,486	9,785	14,627	25,907
Chesapeake Bay	46,657	6,025	10,410	17,767	39,329
Ohio	99,457	4,154	6,748	11,055	23,041
Eastern Great Lakes	33,278	4,800	7,995	13,482	30,471
Western Great Lakes	30,283	10,639	17,502	30,641	71,965
Upper Mississippi	46,125	3,350	5,321	8,275	16,133
Lower Missouri	16,211	957	1,657	2,896	5,703
Southeast	186,030	25,451	48,176	87,941	186,781
Cumberland	14,647	1,810	4,280	9,088	23,529
Tennessee	40,389	3,019	5,742	10,381	24,493
Lower Mississippi	35,207	3,130	5,311	8,536	16,732
Lower Arkansas-White-Red	57,661	3,099	4,463	6,064	10,114
Upper Missouri	25,600	15,912	18,179	24,084	38,553
Upper Arkansas-White-Red	7,053	6,730	7,486	8,969	14,550
Western Gulf	25,900	17,235	26,747	44,441	98,408
Upper Rio Grande-Pecos	3,000	5,507	6,529	8,921	12,901
Colorado	11,400	16,950	25,204	42,643	65,373
Great Basin	6,934	6,251	7,011	10,046	18,038
South Pacific	815	8,135	12,278	18,055	26,098
Central Pacific	45,478	26,834	30,309	37,267	54,872
Pacific Northwest	134,570	25,068	36,886	58,005	96,342
United States	956,219	204,719	302,541	470,658	909,268

REGIONAL ISSUES

	Reference Number						
	334	84	84	84	84	84	84
Region/Area	Bay Area	New York City	Detroit	Los Angeles	Baltimore	St. Louis	San Francisco
Water Use							
Residential - Inside	346 mgd						
- Outside	155.2 mgd						
Total	501.2 mgd or 31.8% of total water use	154 gcd	154 gcd	175 gcd	152 gcd	217 gcd	120 gcd
Year		1960	1960	1960	1960	1960	1960

RESIDENTIAL WATER USE

Reference Number 138

LEVELS OF WATER CONSUMPTION

Per Capita Use Gallons Per Day (gpcpd)	Four	Five	Six	Seven	Eight	Convervation Rating
100	400	500	600	700	800	VERY HEAVY, no conservation evident
75	300	375	450	525	600	HEAVY USE, including lawn & garden watering
60	240	300	360	420	480	NORMAL USE, with some outside lawn & garden watering
45	180	225	270	315	360	MODERATELY CONSERVATIVE with little or no grass watering and some selective garden watering
30	120	150	180	210	240	VERY CONSERVATIVE household use, no outside watering

RESIDENTIAL WATER USE

Reference Number 83

		BI-MONTHLY	DAILY
1.	One or two residential units	400 cu. ft. = 2992 gallons	49 gallons per person
	a. one permanent resident	700 cu. ft. = 5236 gallons	43 gallons per person
	b. two permanent residents	1000 cu. ft. = 7480 gallons	41 gallons per person
	c. three permanent residents	1200 cu. ft. = 8976 gallons	37 gallons per person
	d. four permanent residents	1400 cu. ft. = 10,472 gallons	34 gallons per person
	e. five permanent residents	1600 cu. ft. = 11,968 gallons	33 gallons per person
	f. six permanent residents	1800 cu. ft. = 13,464 gallons	32 gallons per person
	g. seven permanent residents		

2. Three or more residential units (the allotment is based on a figure of 2 persons per unit as shown by recent census data.) 650 cu. ft. for each unit.

3. All other uses:
57% reduction from normal use, which is equivalent to an allotment of 52% of 1976 water use.

RESIDENTIAL WATER USE

Reference Number 26

WATER USAGE FOR A FAMILY OF FOUR

	England		United States	
	Percent	Liters/day	Percent	Liters/day
W. C. flushing	35	196	39	380
Personal bathing	35	196	31	300
Laundry	10	56	14	130
Washing up	10	56	3	30
Car washing, garden	6	32	-	-
Drinking, food preparation	4	24	11	100
Utility sink	-	-	2	20
		560		960

RESIDENTIAL WATER USE

	Reference Number				
	54	63	83	100	61
Indoor Use		69%			
Bathroom					
Toilet Flushing	41%	45%	100gpd	100gpd	32gpd
Washing/Bathing	30%	30%	80gpd	80gpd	21gpd
Shower					
Tub Bath					
Shower or Bath					
Toilets and Baths					
Oral Hygiene					
Bathroom Sink			8gpd	8gpd	
Kitchen					
Dishwashing			15gpd	15gpd	
Dishwasher					
Sink					
Garbage Disposal					
Cooking					
Cooking/Washing/Drinking					
Drinking/Cooking		5%	12gpd	12gpd	3gpd
Laundry/Dishwashing		20%		35gpd	14gpd
Laundry			35gpd		
Utility Sink			5gpd	5gpd	
Clotheswasher					
Leaks					
1 drop/sec.					
steady drip					
1/32" trickle					
toilet tank leak					
1/32" @ 40 psi					
1/16" @ 40 psi					
1/8" @ 40 psi					
Miscellaneous					
Number of persons			4	4	1
Region/Area		Bay Area			
Total			255gpd	255gpd	
Outdoor Use					
Garden Hose					
½"					
5/8"					
3/4"					

RESIDENTIAL WATER USE

	Reference Number		
	151	26	127
Indoor Use			
Bathroom			
Toilet Flushing	41%-102g	39%	100gpd-39%
Washing/Bathing			
Shower			
Tub Bath			
Shower or Bath			
Toilets and Baths			
Oral Hygiene			
Bathroom Sink			
Kitchen			
Dishwashing		3%	
Dishwasher			
Sink			
Garbage Disposal			
Cooking			
Cooking/Washing/Drinking			
Drinking/Cooking		11%	
Laundry/Dishwashing			
Laundry		14%	39gpd-14%
Utility Sink			5gpd-2%
Clotheswasher	4%, 6g. hot & 4g. cold		
Leaks			
1 drop/sec.			
steady drip			
1/32" trickle			
toilet tank leak			
1/32" @ 40 psi			
1/16" @ 40 psi			
1/8" @ 40 psi			
Miscellaneous			
Number of persons			
Region/Area			
Total			
Outdoor Use			
Garden Hose			
½"			
5/8"			
3/4"			

RESIDENTIAL WATER USE

	26	113	132	148
Indoor Use				
Bathroom				
Toilet Flushing	100g/5g/use-day		5g/flush	
Washing/Bathing				
Shower		29g	4g/minute	
Tub Bath			30g	
Shower or Bath	80g/4g/min.-day			
Toilets and Baths				
Oral Hygiene				
Bathroom Sink	8g/day			
Kitchen				
Dishwashing				
Dishwasher	15g/15g/load-day		14g/load	
Sink	12g/day			
Garbage Disposal				
Cooking				
Cooking/Washing/Drinking				
Drinking/Cooking				
Laundry/Dishwashing				
Laundry	35g/50g/load-day			
Utility Sink	5g/day			
Clotheswasher			50g/load	
Leaks				
1 drop/sec.			7g/day	
steady drip			20g/day	
1/32" trickle			200g/day	25g/day
toilet tank leak			200g/day	
1/32" @ 40 psi				
1/16" @ 40 psi				
1/8" @ 40 psi				
Miscellaneous				
Number of persons	4			
Region/Area				
Total	255g/day			
Outdoor Use				
Garden Hose				
½"				
5/8"				
3/4"				

RESIDENTIAL WATER USE

	Reference Number		
	40	81	9
Indoor Use			
Bathroom			
Toilet Flushing			14.7gpcd 4.1g/use 3.6use/day
Washing/Bathing			
Shower	5-6g/minute		
Tub Bath			
Shower or Bath			8.7gpcd 27.2g/use .32use/day
Toilets and Baths			
Oral Hygiene			
Bathroom Sink			
Kitchen			
Dishwashing		15-25g/load	
Dishwasher		7½-16g/load	1.1gpcd 7g/use .15use/day
Sink			7.6gpcd 1.7g/use 14.5use/day
Garbage Disposal			.8gpcd 2.1g/use .4use/day
Cooking			
Cooking/Washing/Drinking			
Drinking/Cooking			
Laundry/Dishwashing			
Laundry			
Utility Sink			
Clotheswasher		25-50g/load	11.6gpcd 38.6g/use .3use/day
Leaks			
1 drop/sec.			
steady drip			
1/32" trickle			
toilet tank leak			
1/32" @ 40 psi			
1/16" @ 40 psi			
1/8" @ 40 psi			
Miscellaneous			
Number of persons			
Region/Area			
Total			
Outdoor Use			
Garden Hose			
½"			
5/8"			
3/4"			

RESIDENTIAL WATER USE

	Reference Number				
	130	137	113	113	113
Indoor Use					
Bathroom					
Toilet Flushing	39%				
Washing/Bathing	31%				
Shower			35g		5 min. 31g/shower
Tub Bath					
Shower or Bath				80g/day/home	
Toilets and Baths					
Oral Hygiene	3%				
Bathroom Sink					
Kitchen					
Dishwashing	6%				
Dishwasher					
Sink					
Garbage Disposal					
Cooking					
Cooking/Washing/Drinking					
Drinking/Cooking	5%				
Laundry/Dishwashing					
Laundry	14%				
Utility Sink					
Clotheswasher					
Leaks					
1 drop/sec.					
steady drip					
1/32" trickle					
toilet tank leak					
1/32" @ 40 psi		170gpd			
1/16" @ 40 psi		600gpd			
1/8" @ 40 psi		2500gpd			
Miscellaneous	2%				
Number of persons					
Region/Area					
Total					
Outdoor Use					
Garden Hose					
½"					
5/8"					
3/4"					

RESIDENTIAL WATER USE

	Reference Number			
	113	113	113	113
Indoor Use				
Bathroom				
Toilet Flushing				
Washing/Bathing				
Shower	15-20g.	5 min. 30g/shower	30-60g.	15-25g
Tub Bath				
Shower or Bath				
Toilets and Baths				
Oral Hygiene				
Bathroom Sink				
Kitchen				
Dishwashing				
Dishwasher				
Sink				
Garbage Disposal				
Cooking				
Cooking/Washing/Drinking				
Drinking/Cooking				
Laundry/Dishwashing				
Laundry				
Utility Sink				
Clotheswasher				
Leaks				
1 drop/sec.				
steady drip				
1/32" trickle				
toilet tank leak				
1/32" @ 40 psi				
1/16" @ 40 psi				
1/8" @ 40 psi				
Miscellaneous				
Number of persons				
Region/Area				
Total				
Outdoor Use				
Garden Hose				
½"				
5/8"				
3/4"				

RESIDENTIAL WATER USE

	Reference Number				
	5	5	5	5	84
Indoor Use					
Bathroom					
Toilet Flushing					25gpcd-39%
Washing/Bathing					
Shower					12gpcd-19%
Tub Bath					8gpcd-12%
Shower or Bath					
Toilets and Baths					
Oral Hygiene					
Bathroom Sink					3gpcd- 5%
Kitchen					7gpcd-11%
Dishwashing					
Dishwasher					
Sink					
Garbage Disposal					
Cooking					
Cooking/Washing/Drinking					
Drinking/Cooking					
Laundry/Dishwashing					
Laundry					
Utility Sink					
Clotheswasher					
Leaks					9gpcd-14%
1 drop/sec.					
steady drip					
1/32" trickle					
toilet tank leak					
1/32" @ 40 psi					
1/16" @ 40 psi					
1/8" @ 40 psi					
Miscellaneous					
Number of persons					
Region/Area					
Total	246g/day	247g/day	233g/day	255g/day	
Outdoor Use					
Garden Hose					
½"					
5/8"					
3/4"					

RESIDENTIAL WATER USE

	Reference Number			
	138	57	79	32
Indoor Use			75%	
Bathroom				42%
Toilet Flushing	45%	45%-sfh, 67%- apt.		
Washing/Bathing	35%			
Shower				
Tub Bath				
Shower or Bath				
Toilets and Baths				
Oral Hygiene				
Bathroom Sink				8%
Kitchen				
Dishwashing				32%
Dishwasher				
Sink				
Garbage Disposal				4%
Cooking				
Cooking/Washing/Drinking				
Drinking/Cooking				14%
Laundry/Dishwashing				
Laundry				
Utility Sink				
Clotheswasher				
Leaks				
1 drop/sec.				
steady drip				
1/32" trickle				
toilet tank leak				
1/32" @ 40 psi				
1/16" @ 40 psi				
1/8" @ 40 psi				
Miscellaneous				
Number of persons	household			
Region/Area				
Total				
Outdoor Use				
Garden Hose				
½"				
5/8"				
3/4"				

RESIDENTIAL WATER

	Reference Number	
	63	132
Indoor Use		
Bathroom		
Toilet Flushing		
Washing/Bathing		
Shower		
Tub Bath		
Shower or Bath		
Toilets and Baths		
Oral Hygiene		
Bathroom Sink		
Kitchen		
Dishwashing		
Dishwasher		
Sink		
Garbage Disposal		
Cooking		
Cooking/Washing/Drinking		
Drinking/Cooking		
Laundry/Dishwashing		
Laundry		
Utility Sink		
Clotheswasher		
Leaks		
1 drop/sec.		
steady drip		
1/32" trickle		
toilet tank leak		
1/32" @ 40 psi		
1/16" @ 40 psi		
1/8" @ 40 psi		
Miscellaneous		
Number of persons		
Region/Area		
Total		
Outdoor Use	31%	
Garden Hose		
½"		360g/hr
5/8"		600g/hr
3/4"		1140g/hr

WATER RATES

Reference Number

	130	105	77
Area/Region	Fairfax County, VA	Marin County, CA	E. Bay, CA
Rates	60-68¢/1000 gal.; >30% of winter use, rates = $2.60/1000 gal.	0 to x $1.63/1000 gal. x to 2x $13.37/1000 gal. > 2x $66.87/1000 gal.	0-500 cu. ft. - 29¢/cu. ft. next 3500 cu. ft. - 39¢/cu. ft. next 396,000 cu. ft. - 37¢/cu. ft. >400,000 cu. ft. - 33¢/cu. ft.
Type of User	All Types	Residential	

WATER SAVING TIPS

TOILET

Habits/Frequency of Use

- Don't use the toilet simply to flush away facial tissues, paper, and other similar solid and liquid wastes (using a wastepaper basket is a lot cheaper).

- Flush the toilet less often. In most cases, several uses can be made of the toilet for liquid wastes before flushing is required. A deoderant and colorant block in the flush tank may make this practice aesthetically more acceptable.

Maintenance/Leaks

- Toilets are notorious for their hidden leaks, and they can waste thousands of gallons of water a day undetected. A toilet will leak when it is out of adjustment or when its parts are worn, so it is important to check it periodically.

  A toilet usually leaks at the overflow pipe or at the plunger-ball. If it is at the overflow it is generally because the water level is too high, though sometimes the overflow pipe develops a leak below the water level. You should gently bend the float arm down so that the valve shuts off 1/2 inch below the top of the overflow pipe or at the level indicated on the inside of the tank. Often the valve is worn and will run like a leaky faucet, and it will probably need replacement. Overflow leaks can be detected by a visual inspection, although they are not always obvious.

  Plunger-ball leaks are not as easy to see. The easiest way is to drop a little food coloring into the tank and wait to see if it shows up in the bowl. If it does you probably have a leak at the plunger-ball, either because the ball needs replacing, or because the mechanism is out of alignment. Even if you don't see the color in the bowl you might still have to replace the ball if you occasionally have to jiggle the toilet handle or hear a low hum. Bent or scummy connecting rods can hang up and cause leaks too.

- Another simple way to check for a flush ball leak is to place a piece of toilet paper on the dry part of the bowl just above the water line. Since the water from the leak flows through the holes in the rim of the bowl just above the water line, the paper will become wet if there is a leak. The average life of a flush ball is seven years, and as it becomes older, the possibility of a leak increases greatly. A new flush ball can be purchased for less than $2, and it might be a good policy to change the flush ball every 5 years just to be safe.

- Infrequently, the valve seat is scarred and needs replacing. It can be tested by running a finger around the seat to see if it is completely smooth. It should be free of dirt or corrosion, which would prevent a complete seal. Original seats are generally brass and may be replaced by a plumber. A kit which bonds a new seat to the old one with an adhesive is available for do-it-yourselfers.

- Obviously, if the toilet tank continues to make noise after the flush-and fill cycle is completed, something is wrong within the tank. Usually the problem is caused by the flush ball not fitting properly into its valve seat. This misfit is often caused by a bent or corroded guide wire or an improperly positioned guide arm. A replacement for the flush ball is available which uses a flapper assembly, eliminating the need for the guide wire and guide arm.

- There are two other common causes of loss of water that can be detected easily. If the water level in the flush tank is above the overflow tube, water will continually run out. This problem occurs because the float is set too high or the ball cock is leaking. The water level in the tank should always be at least 1/2 to 1 inch below the overflow through the refill tube. Lowering the float or repairing the leak in the ball cock will prevent these losses.

- Another reason for the water to run out of the tank continually is a defective float. If the float leaks, it will not rise high enough to shut the water off after the tank refills, and water will overflow into the bowl. You can test the float by taking it off and shaking it. If you hear water inside, it should be replaced. Foam plastic balls cannot become waterlogged.

- Check the flush handle mechanism - it might be sticking and keeping the stopper ball from going into place.

- Inspect vertical overflow pipe for pitholes below the waterline. Replace if any are found.

Devices/Water Displacement

- Your present toilet can also be improved to cut down considerably the amount of water needed for each flush. Commercial devices include a simple flexible toilet dam made of moulded plastic and rubber and held in place by suction. When wedged into the tank around the drain hole, this device holds back 1 to 2 gallons per flush.

- Home made devices can also be constructed to do the same thing. Plastic bottles, filled with clean stones and water for ballast can be placed in your tank to displace and save water. You may have to work with this a bit to make certain you do not displace so much water that two flushes are required to get rid of wastes. Please reconsider putting bricks in your toilets since they can disintegrate over time and hurt the toilet tank.

- Partial/full flush systems are flooding the market. Two large brass washers on the lower lift wire or on the flapper chain can give the homeowner the same choice.

WATER SAVING TIPS

- When remodeling or repairing, install low-flush toilets and shower and faucet flow control devices.

BATHING & PERSONAL HYGIENE

- Take shorter showers. Unless a shower lasts seven minutes or less, bathing in the tub will use less water and will conserve energy. A kitchen timer is a useful bathroom accessory. The "Navy" shower - use water to get wet, turn off water while lathering, turn on water to rinse - uses the least water. The amount of water used in a tub-shower is easily determined by closing the drain during the shower.
- A partially filled tub bath will use far less water than a long shower, though a short shower may use less than a full tub.
- Don't fill the bathtub too full. Usually, 1/4 of a tubful is enough to cover the body and also float the kids toy boat or rubber duck! And, it's best not to let little children fill their own tub...they'll fill to the brim every time!
- When filling the tub, don't let water run down the drain until it gets hot. Instead, close the drain before turning on the faucet. The water will soon be hot and the temperature can be adjusted later as the tub fills.
- Turn off the water while brushing your teeth; this step can save a family 5 to 10 gallons per day (or 3650 gallons a year).
- Rinse hand razors in the filled sink rather than under running water.
- When shampooing, turn off the water while lathering the hair.
- If your shower involves the adjustment of two hand controls (one for hot and one for cold), be sure to turn the HOT handle FIRST and let it run to get the water warm before turning on the COLD to mix for the "just right" temperature. Thus, you will not be wasting water from the cold feed while you're waiting for the hot feed to warm up.
- Use inexpensive flow control devices which can save from one to four gallons a minute (a 25 to 50% reduction).
- Reduce pressure in water flowing to shower or sink.
- Install low flow shower heads, or quick cut-off shower heads for "Navy" showers.
- Turn down hot water temperature to reduce mixing cold and hot.
- Brush teeth first using cold water in hot-line while waiting for the hot water.
- Use glass of water to rinse your mouth rather than cleaning brush under water flow repeatedly and brushing teeth several times. You'll save

your teeth and water.

- Consider shaving with an electric razor; it's cheaper than heating the hot water for a safety razor shave.

DRINKING, COOKING & WASHING

- A leaking faucet wastes more water than most people realize. A leak of 1 drop per second can waste 7 gallons per day. A steady drip will waste 20 gallons per day.

  Faucet leaks are easy to see and comparatively easy to repair. Installing a new washer, a simple task, will usually correct the leak. If the faucet begins leaking again soon after the washer is changed, it may be necessary to replace the valve seat because it probably has a small scar on it which cuts the washer. "Do-it-yourself" books or hardware store personnel may provide useful advice.

- When filling a kettle, try to estimate the exact amount needed; leaving unused boiled water on the stove means that both water and energy have been wasted.

- Use plastic ice trays which permit the cubes to be loosened by twisting the tray rather than running water over the tray.

- Keep a bottle of water in the refrigerator rather than letting water run in the sink to get a cool drink.

- When cleaning vegetables, use a filled sink and a vegetable brush, and wash all the vegetables for a meal at once.

- Use only the minimum water to cook foods; flavor and food value may be wasted along with water.

- Do not use garbage disposals except at the end of cooking or clean-up periods or when full. Whenever possible, don't use the disposal at all; compost vegetable peelings for your garden or put them in the garbage can.

- Run an automatic dishwasher only with full loads. Do not prewash dishes unless necessary. To save energy, turn the dishwasher off at the start of the dry cycle, open the door, and let the dishes air-dry.

- Do not use the extra-long prewash and scrub cycles on the dishwasher unless absolutely necessary.

- If you are in the market for a new dishwasher and are also interested in saving water, shop around a bit and obtain information from manufacturers on how much water their machines require for operation. Automatic dishwashers last for a long time, so a saving of a few gallons per cycle over a period of many years can add up to a lot of money. Spending a few days to find the right water-saving buy in dishwashers will pay off in the long run.

WATER SAVING TIPS

- Do not let faucets run for washing or rinsing. Always fill a container with water for this purpose or use the sink by stoppering the drain.
- Use a brush, wash cloth, or your hand to dislodge particles of dirt when washing anything rather than relying on the force of the water to do the job.
- Some housewives suggest the addition of vinegar (1/4 to 1/2 a cup) to wash water to prevent grease from clinging to dishes, pots and pans. This apparently helps eliminate the use of strong, grease cutting cleaners and cuts down on the required volume of rinse water.
- Grease and oil should never be poured down the drain. Besides clogging up the drain, you use a great deal of water rinsing them down.
- When washing leafy vegetables (lettuce, spinach, kale), place them in a container and cover them with water. Some housewives add a teaspoon of salt. Allow the vegetables to soak for a few minutes. Then provide a fast, crisping rinse. The soaking eliminates much of the need for a lot of scrubbing and repeated rinsing.
- When cooking, barely cover the food with water. Use a tight fitting lid to conserve moisture...and there is no need to drain off and throw away water used in cooking. Water boiled with vegetables contain nutrients and can be utilized for soups and sauces.
- Practice taking food from the freezer to thaw in plenty of time to avoid the need for quick thawing. Some cooks who do not plan their schedules to provide time for thawing at room temperatures, waste water by running it out of the spigot and onto the package to force-thaw frozen foods.
- In order to cut down on water needed to clean and scour aluminum pans after boiling foods like spaghetti, some housewives suggest that 1/4 to one teaspoon of lemon juice be added to the cooking water. This makes cleanup easier.
- Remove ice cube trays from the freezer a few minutes before you need the ice. The cubes will soon loosen at room temperature and eliminate the need for expenditure of several quarts of water many family members waste to obtain a quick separation of ice from the frosty tray.
- Use an aerator or sink spray in the kitchen -- it will let you cover more area with less water.
- Run clothes washers only with a full load unless a reduced fill setting is available. Use "warm" or "cold" settings if possible.
- For hand laundering, put a stopper in the washtub for both washing and rinsing, and don't let the water run.
- To save water, always wash a full load. If replacing a machine, shop around to buy a new machine with water conservation design. Consumer

Reports (available for perusal in public libraries if you are not a subscriber) publishes good information on washer ratings.

- Use the "suds-saver" on the washing machine if it has such a feature.
- Allow small children to bath together.
- Consider use of disposable diapers.
- Know the capacity of your hot water heater. Much water can be wasted trying to get hot water out of a cold tank.
- Insulate the hot water pipes between the heater and the faucets to reduce the amount of water that must be run to get hot water. Smaller hot water piping will have similar effect.
- Locate the water heater near the points of most hot water use. Conside a separate water heater for distant bathrooms.

OUTDOOR USE

Lawns/Gardens

- The basic principle to follow when watering the lawn and garden is not to give it more water than it needs. Some people irrigate their lawns with double the water the lawn actually needs to thrive.
- Rather than following a fixed schedule to water the lawn, water it only when it showsthe first signs of needing it. You don't need to water the lawn as often in cool weather and on cloudy days. Watch the weather and the lawn before you decide to water it.
- Heat and wind will rob your lawn of the water before it can use it. Avoid watering on windy days and you will avoid having most of the water going somewhere besides the garden. Water in the cool of the day, both to avoid excess evaporation and the chance of harming the lawn.
- Of course there are circumstances (large areas, limited time) where a sprinkler system is essential. But if you can avoid it and put water on by hand you will probably save water.
- Make sure your sprinklers and hoses are adjusted to water just your lawn and garden. Irrigating sidewalks and gutters will not make them turn green, or grow either.
- Water the lawn in the early morning to avoid evaporation losses.
- For successful lawn irrigation, irrigate slowly, deeply, and infrequently.
- Do not allow sprinkler water to flow into a gutter.
- Avoid sprinklers that produce a fine mist; too much water is lost in wind and evaporation.

WATER SAVING TIPS

- Use an alarm clock or the stove timer to remind you to shut off the sprinklers.
- If you have an automatic sprinkler system, use a moisture sensing device to turn them on and off. With automatic timers, make sure there is a manual override switch so your sprinklers are not watering when it is raining.
- Check hose washers at least annually.
- Keep sprinkler heads clean to assure even distribution of water.
- Use pistol-grip nozzles (spring shut-off) on all hoses to avoid waste, and always turn off the faucet tightly when through to prevent leakage.
- A lawn that is 2 inches high can have a well maintained look and it holds more dew and shades the root systems better than a low cut lawn.
- Deep watering is more efficient than shallow watering and roots will be encouraged to develop deeper and hence enjoy a greater "soil reservoir" of nutrients and water from which to draw upon. The key is to get the water to penetrate deeply and the best overall answer is slow application.
- An ideal soil structure might consist of 45% mineral matter, 5% organic matter, 25% air and 25% water. Air space (loose soil) is most important for it provides the "water holding capacity."

  Soil should have a gentle slope without high and low spots thus providing for balanced distribution of water.
- Proper Density - The soil needs a sufficient amount of air spaces. Compacted soil will hamper water penetration and root growth.
- Smooth down lawn seed. Use a lawn roller and a straight-edge leveling tool to produce a lawn bed free of high and low spots; otherwise uneven irrigation results.
- Dig basins and troughs around trees and bushes to concentrate the water and reduce runoff.
- Water deep and less often. Shallow, frequent watering encourages shallow roots, more evaporation loss and reduces moisture reservoir in the soil.
- You can water with a drip-irrigating system and use approximately half the water you'd use with aboveground sprinklers, furrows, or flooding. If you have enough fresh water, consider a drip system for such uniform plantings as vegetable gardens, beds of annuals, perennials, ground cover areas, rose gardens, hedges and screens, camellia collections, or young orchards.
- Gray-water collecting and distributing systems that home owners have put together take water from bathtubs, showers, sinks, and washing machines and deliver it to big plastic garbage cans for storage. The water may be siphoned to the cans or pumped through tubes by submersible electric pumps that cost about $20 to $30. It can flow into the garden through valves and fittings at the bottoms of the cans.

WATER SAVING TIPS

- If a drip-irrigation system challenges your mechanical ability or costs more than you can afford, soil soakers ($4 to $10) offer you a simple, less expensive and less efficient substitute. Attached to a hose end, these long tubes of plastic or canvas seep or sprinkle water along their entire length.

  Just position the soaker (alongside a row of vegetables or flowers, beneath a hedge, over the root systems of a series of shrubs or trees). Then attach a hose and turn on the water. Turn sprinkle soakers with holes down to avoid water loss from wind or evaporation. It's easiest if you can leave each soaker in place all season.

- They have been on the market for years but became very popular suddenly this year. They are rigid pipe and tube devices that you attach to the end of a hose, push into the soil with your foot, and turn a valve to let water out underground. Most people favor the type that's meant to be an underground feeder. For this year, we recommend that you leave the fertilizer changer empty and use the device just to deliver water to the roots.

- Most garden plants would grow roots 1 to 5 feet beneath the soil surface if they could find enough water there.

  A soil-sampling tube--a hollow coring device with a handle-- can remove a core of soil 15 inches long. In it you can read and feel the state of the soil to that depth. Dry powdery soil means there's not enough water to support root growth. Golf course equipment firms sell the tubes for $11 to $15.

  A long, skinny metal rod pushed into the soil can tell you in a crude way how deep the water goes--if the rod goes in, the soil is probably wet enough.

- Occasionally, about 12 to 24 hours after irrigating, check soil with a soil tube, auger, probe or spade and note depth of water penetration by change in color and feel of soil. If any soil in the root zone is dry, apply water longer in future irrigations.

- Purchase and use a hand tensionmeter probe to check irrigation needs of trees and shrubs. Probe 24 to 36 inches under trees and 12 to 24 inches under shrubs. When gauge reads moderately dry (50 to 70 centibars) apply water you think adequate. Check reading again 12 to 24 hours after irrigating. If this reading is 5 to 15 centibars your irrigation was correct. If less than 5, apply less water next time. If more than 15, apply more water next time.

- When irrigating clayey or tight soils, apply water over short periods separated by a soaking-in period of at least twice the length of the application, i.e. 10 minutes on, 20 minutes off, 10 minutes on, etc.

- When irrigating sandy loam or open soils, apply water rapidly and in one continuous period.

- Treat steep slopes like you would a clayey (tight) soil area.

WATER SAVING TIPS

- Aerate lawn annually to avoid compaction and hence rapid run-off.
- Fertilize your lawn with care. A well nourished lawn requires less frequent sprinkling.
- Take pains to make a happy home for new turf by building up soil with nitrogen balanced sawdust, rice hulls or other organic amendment. The time taken to build a good root zone will save many hours of irrigation and produce a much more attractive lawn.
- Be careful when planting flower beds and landscaping not to place a high water using plant next to a low water using plant. You can't satisfy both. Check with your nurseryman.
- Reduce evaporation losses from flower and vegetable gardens by using an organic mulch or plastic ground cover between rows.
- Plant native plants or shrubs that require minimum amounts of water.
- In arid areas, use desert landscaping which does not require watering.
- Don't plant in a dry season.

  Planting means watering. If your area is suffering any kind of water shortage, forget about extensive or big-scale planting, hold off planting until fall.
- All plants need water to get established, even drought resistant ones.
- Delay regular watering of grass the first cool weeks of spring to encourage deeper rooting.
- If you are planting a garden, poke holes in the bottom of a big can or plastic bottle; "plant" a can next to the seeds or little plant. To water or fertilize, just put the liquid in the can; everything goes to the root zone where it's needed.
- Punch 1/4-inch holes about one inch apart around each plant in your garden. If the holes are 3 or 4 inches deep, filling them just once will give the plant enough water.
- Antitranspirants put a temporary moisture seal on the surface of leaves to prevent moisture loss. They are good for protecting broad-leafed plants from frost and for minimizing wilt during transplanting jobs. The verdict of our panelists was that they aren't effective in reducing irrigation during the summer.
- The hoe is a wonder implement. With it you can regularly chop off the tops of emerging weeds which, if left to grow, could cause a major loss of your valuable soil moisture.
- Containers may be water-wasteful.

  When you water plants in containers, the excess water that goes through the drain holes is wasted unless it runs directly onto soil where other plants have roots. Also, clay pots and wooden containers lose some water through their sides. And container plants evaporate water faster than plants in the ground because the isolated soil mass heats faster and gets more wind.

Water liftable containers by submerging them in a large tub until bubbles stop rising. Then lift the container and let it drip into the tub.

When possible, move containers into a little more shade and a lot less wind. Just grouping them close together makes them lose less moisture.

Clay pots are very porous (that's their desirable feature--they let roots "breathe"). To reduce water loss you can put one clay pot inside another or spray their outsides with silicone sealer for one dry season (it wears off), or bury them up to their rims in a garden bed. A mulch over the soil surface in containers reduces water loss by evaporation. It should be no-float material. Pebbles and gravel are good. Or, cut a circle or square of plastic film to fit in the container and make a single slit from edge to center. Open the slit around the stem to place the film on the soil surface.

- Collect water from roof gutters to use for lawn and plant watering.
- Dot water lawns or wash cars when water is in short supply.

Other Outdoor Uses

- When washing the car, rinse it once, then use a bucket of soapy water to wash it, and then give it one more quick rinse. Taking it to a car wash may save water, since many commercial installations recycle their water.
- Using a hose instead of a broom is wasteful also. It isn't the best use of water to shoot it down the gutter, so use a rake and a broom to clean up the leaves and debris on your sidewalks, yard, and gutters.
- If you own a swimming pool, consider purchasing a cover to cut evaporation, chemical and heating costs dramatically.
- Keep pool water at least 6 inches down from edge of pool to reduce splash loss.
- And on those hot summer days when kids are just itching for a water fight, we would suggest water ballon battles rather than garden hose fights, and use the lawn as the field of valor.

WATER & SEWAGE

- Your water meter is the best detective in the home. It can tell whether you have sizable leaks, as well as how much water various appliances are using. All you have to do is learn its language.

  Most meters record gallons just as your car's odometer records mileage. However, some show cubic feet of water used. For these, you can multiply the figure shown by 7.5, the approximate number of gallons in one cubic foot.

1. It is summer, turn on the sprinkler and watch the meter dial move for precisely one minute. Multiply the number of gallons times 60 for quantity used per hour. Then estimate how long you usually leave the sprinkler running. You may be shocked at the hundreds of gallons going onto the lawn and garden every week.

2. Wait for a member of the family to step into the shower and follow the same timing routine. Check the volume consumed in one minute and multiply by the number of minutes a normal shower in your family takes.

3. Watch the meter dial through a full fill cycle on the automatic washer. And remember that each wash gets more than twice as much for both wash and rinse.

4. For leak detection, turn everything off carefully so no water is being used anywhere in the house. Then check the position of the meter dial for about 15 minutes. If it hasn't moved, congratulations! You have a relatively water-tight home. But if it has, start checking hose connections, faucets, the toilet (with food coloring, remember?).

   Sometimes a meter located outside of the house at curbside will indicate a leak when everything inside seems tight. The leak may be hidden underground in the pipes. Call a plumber for advice.

- When you go on a vacation, turn off the water to the house; a leak while you are away could be expensive and do a lot of damage. Be sure, however, to turn off the water heater also. If it should begin to leak and drain dry, it could burn out.

- In case of a broken pipe or other "blow out", immediately shut down nearest shut-off valve. Instruct family members on where shut-offs are located and how to turn them off; also where the wrench is kept in case they are stubborn.

- The foundation area under your house should remain powder dry. If it isn't, check for a pitted pipe or a leaky joint.

SUBJECT INDEX BY BIBLIOGRAPHY REFERENCE NUMBER

SUBJECT INDEX BY REFERENCE NUMBER

WATER CONSERVATION TIPS	REFERENCE NUMBER
Toilet	3,20,27,47,51,52,55,56,74,75,79,83,93,125,128,129,132,133,135,137,138,140,141,143,147,148,153
Bathing & Personal Hygiene	3,20,27,47,51,52,55,56,79,83,93,125,128,129,132,133,135,137,138,140,141,143,147,148,153
Drinking, Cooking, Washing	3,20,27,47,50,51,52,79,83,93,125,128,129,132,133,135,137,138,140,141,147,153
Water & Sewage	3,20,27,47,51,52,83,93,125,128,129,132,135,137,140,141,147,153
Outdoor Uses	3,15,19,20,27,28,35,47,51,52,54,55,60,72,73,79,83,93,97,101,102,117,122,123,124,125,127,128,129,131,132,133,135,137,138,140,141,146,147,148,153,155
Other	3-How to read meter

WATER CONSERVATION DEVICES	
Toilet	2,23,24,110,120,126,130
shallow trap toilets	36,40,51,52,56,57,79,84,85,98,106,118,128,132,137
chemical	56,57,85,89
wastewater recycling	42,56,57,82,84,85,89,95,98
pressurized flush	23,24,36,40,56,57,85,106
pressurized tank	21,36,56,57,85,89,93
controlled volume flush	2,28,85,118,122,126,150
oil flush	36,56,57,84,85,89
composter	56,57,85,89
vacuum	2,36,84,85,89,93,98
packaging	36,56,57,85,89
freeze	36,56,57,85,89
incinerator	36,56,57,85,89,98
hydraulic odor vent	85
leak signalling ballcock	36,85
tank flushing valve	23,24,40,85,89,93,106,118

SUBJECT	REFERENCE NUMBER
variable flush attachment	23,24,40,51,52,55,56,57,79,84, 85,106,128,132,145,150
dual flush	2,36,40,42,56,57,81,84, 85,98,100,101,106,116,118, 122,126,128,132,150
water closet inserts	2,23,24,26,28,30,32,36,40,42, 49,50,51,52,55,56,57,79, 81,84,85,86,93,98,100,101, 106,116,118,122,126,128,132, 137,144,149,150
Bathing & Personal Hygiene	
flow controls	2,18,22,23,24,26,27,28,32, 40,41,42,48,49,50,51,52,55, 56,57,81,84,85,87,88,93,98, 100,101,106,111,113,116,118, 120,122,126,128,130,132,136, 137,140,142,145,147,150,151, 153,154
aerators & spray taps	23,24,26,28,36,40,41,42,45,48, 56,57,62,81,84,85,88,98,106, 113,116,118,120,126,128,130, 132,137,150,151
self-closing mixing valves	26,36,56,57,85,120
pressure-balancing mixing valves	26,36,56,57,85
thermostatically controlled mixing valves	26,36,56,57,85,93,128,132
air-assisted shower heads	2,36,40,56,57,85,93,100,101,106,107
sinks & tubs	81,85,138
whirlpool spas & communial bathtubs	85,137
Drinking, Cooking & Washing	
bottled water	85
solar stills	85
chilled water dispenser	85
instant hot water tap	85
garbage grinders	84,85
automatic dishwashers	17,28,56,5781,84,85,98,120, 143
automatic clothes washers	2,16,28,36,41,42,51,52,56,57, 81,84,85,98,113,120,142
Water & Sewage	
water meter	2,8,26,84,85,102,103,104 105,113,118,120,126,130
water pressure reducing valve	55,56,57,85,93,118,120,122, 126,130,132,137,152

SUBJECT	REFERENCE NUMBER
water pipe insulation	36,85,93,141,146
hot water recirculating systems	36,56,57,85
electrically controlled plumbing systems	56,57,85,93
water heaters	85
water filters & softeners	2,85
grey water filters	85,122,126
evaporative air cooler	85
septic wastewater treatment	9,85,118
aerobic wastewater treatment	9,85
community wastewater treatment	39,40,85,118
Outdoor Uses	
hose attachments	2,56,57,60,85,120,122,126,132,137
instantaneous moisture indicators	56,57,85,120
tensiometers	85
timer controlled lawn sprinklers	51,52,56,57,64,85,93,120,148
drip irrigation	2,48,56,57,60,80,84,85,101,102,118,121,122,124
swimming pool covers	85,118
ECONOMICS	
Cost of devices & appliances	2,7,33,40,85,93,100,101,107,111,120,139,144,153
Possible cost-savings	2,5,6,7,23,25,26,33,57,58,59,63,85,88,95,96,104,105,107,111,120,121,124
Utility rate structures	2,8,26,28,34,39,54,66,68,69,77,81,84,85,90,93,104,105,106,112,115,122,126,130,131,134,136,149
REGIONAL VARIABLES	
Water demand/consumption	2,9,26,33,59,60,63,70,71,83,85,95,108,117,120,124,125,128,129,133,134,138,149
Water uses	2,9,26,33,63,70,71,81,85,88,96,108,124,125,128,129

SUBJECT — REFERENCE NUMBER

Water costs 2,33,85,92,95,125,129,134,149,152
Energy costs 2,5,23,26,33,85,92,94,95,96,152
Local issues 2,33,38,39,54,58,59,60,83,85,89,108,119,134,149
Region/area 9,70,71,134,149

WATER CONSERVATION PROJECTS

Development of consumer handbooks 2,10,12,65,78,81,108,114,130,135
Public participation/education efforts 12,13,23,25,26,29,31,39,43,53,54,58,59,61,63,67,70,73,74,75,76,78,84,85,91,92,105,106,108,123,126,127,130,135,154
Public acceptance of water conservation 1,4,11,12,14,23,25,29,37,38,44,46,52,53,58,59,63,67,68,72,85,90,91,92,100,104,105,108,109,111,126,130
Target audiences. 12,26,43,78

☆U.S. GOVERNMENT PRINTING OFFICE: 1980-311-132/34